Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

ENERGY ALTERNATIVES FOR ONTARIO REMOTE COMMUNITIES

A Strategy and Implementation Plan

Canada

ENERGY ALTERNATIVES FOR ONTARIO REMOTE COMMUNITIES

A strategy and implementation plan

Prepared for:

Remote Community Demonstration Program
of Energy, Mines and Resources Canada

Prepared by:

DPA Consulting Limited
and
Marbek Resource Consultants Ltd.

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EXECUTIVE SUMMARY

Introduction and Background

This is the final report on a study undertaken by DPA Consulting Limited and Marbek Resource Consultants Ltd. on behalf of Energy, Mines and Resources Canada as part of the Remote Community Demonstration Program.

The purpose of this study is:

> "To develop a strategy and implementation plan for the Government of Canada for reduction of dependence on petroleum in remote communities* in Ontario, through the utilization of alternate energy resources and technologies and energy conservation measures."

During the course of the study it became apparent that the major direct users of fossil fuels are government institutions. Residents use some fossil fuels directly for transportation and cooking, but their largest use of energy is for space heating which is met primarily by burning wood. The Study Team perceived that there were opportunities for addressing some of the needs of residents through the energy sector, but that some of these opportunities could not easily be realized in a strategy focussed exclusively on reducing petroleum use.

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*For this study, a remote community is defined as:

- having more than 10 permanent households; and,
- not having access to the Ontario Hydro grid or a gas pipeline.
- Appendix A presents a list of remote communities in Ontario.

It was therefore agreed with the Steering Committee for the study that the scope of the strategy should be broadened to include the following objectives:

- to reduce dependence on fossil fuels in the remote communities;
- to maximize the potential for energy conservation (both wood and fossil fuels);
- to maximize the job creation and organizational development potential arising from the need to supply and/or conserve energy; and,
- to use the supply and conservation opportunities to enhance the range of services available, living conditions and life-styles in the communities.

The Study Team carried out a work program that included consultations with officials, review and analysis of the existing documentation and follow-up contacts with key oficials and data sources. Members of the Study Team also visited a number of remote communities during the study time period and had the opportunity to interview community representatives.

In analyzing the context for the strategy the Study Team drew upon the available data base to determine:

- present and projected energy consumption patterns (end-use and end-users of energy);
- renewable resource potential; and,

- technical options for the use of renewable resources and for energy conservation.

The following paragraphs outline in summary form the key findings with regard to the context for the strategy.

Context for the Strategy

Energy Consumption

Exhibit E-1 shows energy consumption by fuel type. The following points are very important in providing the context for the strategy.

- Wood accounts for 43% of total energy consumption and is used primarily for residential space heating.

- Gasoline and other fuels (kerosene, propane, etc.) account for 11% of total energy consumption, and are used for transportation, cooking, small motors, and etc.

- Fuel oil is by far the most important fossil fuel, accounting for 46% of all energy consumption, and is used largely for electricity generation and space heating.

Exhibit E-2 shows fuel oil consumption by end-use category. Clearly, space heating (39.3%) and electricity generation (52.6%) are the most imortant end-users for fuel oil.

Exhibit E-3 shows fuel oil consumption by end-user or end-user group for the two major end-uses, space heating and electricity generation. Ontario Hydro and the Department of Indian Affairs

EXHIBIT E-1: ENERGY CONSUMPTION BY FUEL TYPE

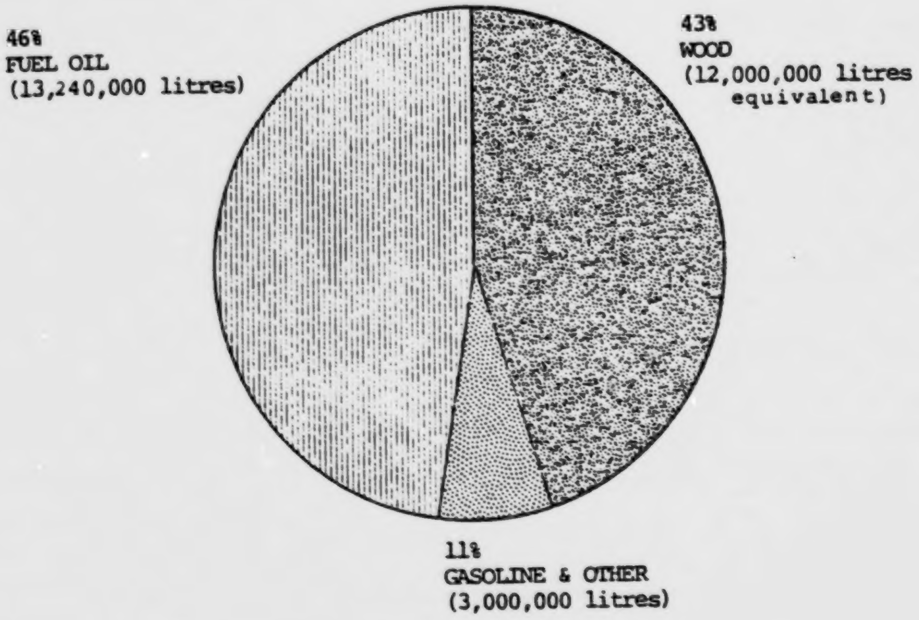


EXHIBIT E-2: FUEL OIL CONSUMPTION BY END-USE

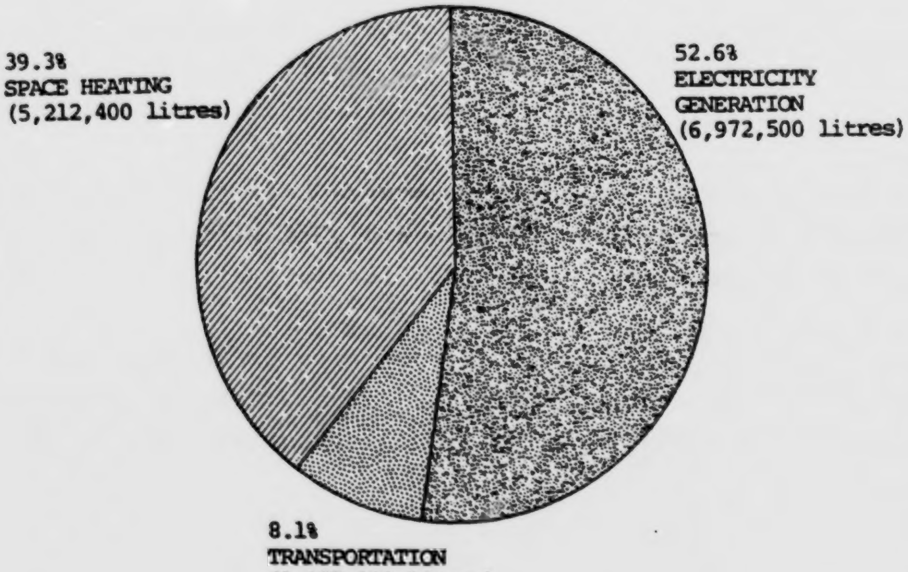
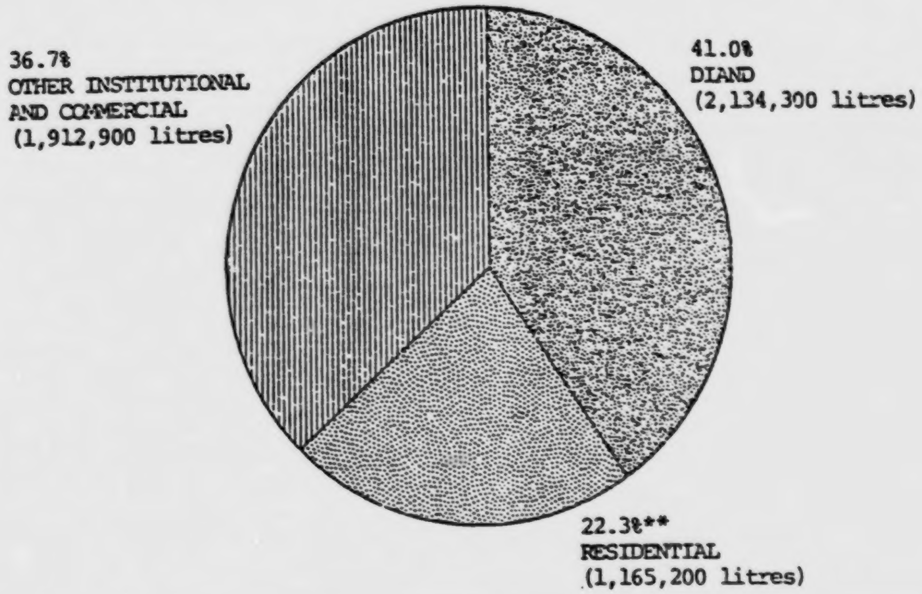
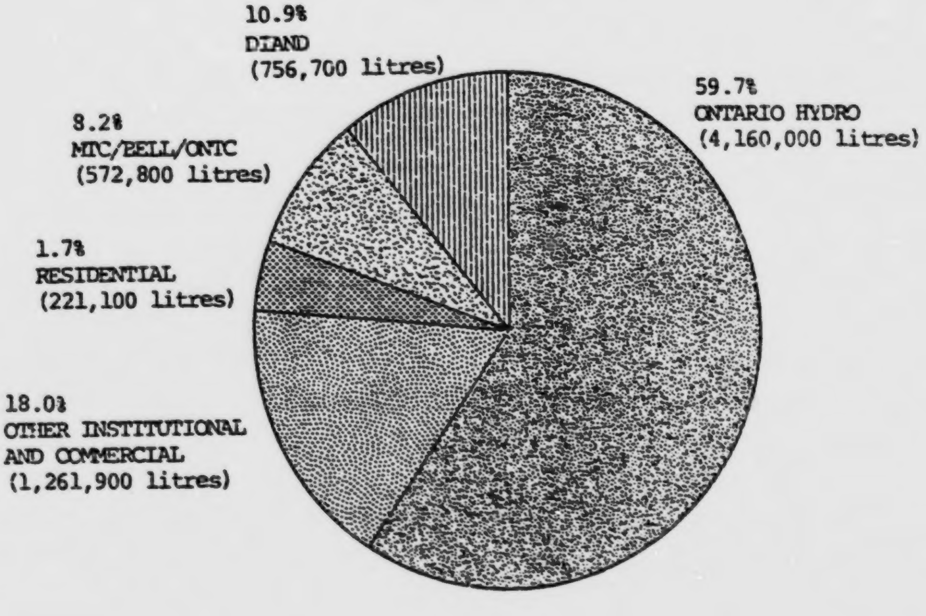


EXHIBIT E-3: FUEL OIL CONSUMPTION BY END-USER
THE TWO MAJOR END-USES (1981)*

SPACE HEATING



ELECTRICITY GENERATION



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* Source: The Remote Community Data Base, Ontario Ministry of Energy, 1982
** Primarily Armstrong and Ramsey Residents

and Northern Development (DIAND) stand out as major end-users of fuel oil. The residential end-use of fuel oil is largely confined to the larger and more sophisticated rail communities.

Renewable Resource Potential

- The available supply of renewable resources in Ontario remote communities is significant and merits serious consideration as a fuel oil substitution option.
- Wood fuel and, in the case of the Hudson's Bay and James Bay communities, wind are two particularly important resources. Micro-hydro resources, though restricted in their availability and subject to high development costs, also represent an important local resource.
- Although peat is believed to be relatively widely available, further site specific data are required before a workable assessment can be made.
- Solar resources are adequate for passive solar heating applications as well as small-scale photovoltaic applications.

Technical Options

The Study Team assumed that to be considered eligible for inclusion in this strategy, a technical option should have a proven performance record at least in non-remote settings, and require only demonstration of its feasibility in a remote setting. The report concludes that:

- There is a wide range of technical options for energy conservation and the use of renewable resources.

. The technical options directed towards space heating (conservation) are ready for widespread implementation.

. Wind diesel hybrid systems are very close to being ready for application in those communities where wind regimes are adequate. The results of a demonstration project at Coniston should prepare the way for a demonstration project at a remote Native community on the James Bay or Hudson Bay coast.

. Small scale hydro is a proven technology but the high "up-front" costs are a major barrier given the existing decision-making framework. Feasibility studies, carried out on at least two remote sites, have shown micro hydro to be economically attractive when compared to diesel. However, these projects have not proceeded. Consequently, the most important developmental work required here is in reaching an "in-principle" policy decision that, if site specific feasibility could be shown, the capital financing would be available.

. Steam engines have a proven reliability record but their widespread use is constrained by two factors:

    . in most applications (greater than 50kW) continuous system monitoring by a 4th class stationary engineer is required; and,

    . the electrical conversion efficiency of steam engines is relatively low in comparison to other conversion technologies--in order to achieve an attractive system efficiency, it is necessary to use the waste-heat for a space/water heating application.

- Steam turbine engines are relatively efficient and reliable. However, they use high pressure steam and are generally considered to be too sophisticated for most remote community applications.

- Gasifier technology is developing rapidly but has not yet reached suitable levels of reliability for most remote, stand-alone applications.

- Wood harvesting techniques are fully developed, but to date there has been no demonstration at the required scale for alternative energy generation in a remote Native setting.

- Peat harvesting technology is commercially available, and is widely used in Europe often at a much larger scale than is required for Ontario's remote communities.

Approach to Developing the Strategy

The Study Team sought to develop a strategy which would provide a balance between intitiatives aimed at reducing fossil fuel consumption and those aimed at the social and economic objectives of the strategy and of the remote communities. The Study Team attempted to identify initiatives where the scope for Federal Government action is substantial and where the use of existing programs can be maximized.

Present and projected energy consumption patterns were the starting point for strategy development. The Study Team developed a list of energy end-use/end-user combinations and then assessed their importance for the strategy in terms of their potential for contribution to meeting the objectives of the strategy and in terms of the other considerations noted in the paragraph above.

This assessment resulted in a number of recommendations which in turn yielded the component parts or elements of the strategy. In broad terms the Study Team recommended that:

- two end-uses of energy, space heating and electricity generation, should be the focus of the strategy;
- while transportation accounts for significant consumption of fossil fuels the technical options to address this sector (e.g. vehicle design) are beyond the scope of this study;
- the greatest short-run progress in achieving objectives could be made through space heating conservation measures and heat recovery for space heating from community power diesel installations; and,
- in the medium to long-term there is considerable potential for achievement of objectives through the use of renewables to generate community power, but only after further developmental work has been completed.

Additional, more detailed recommendations are provided in the body of the report.

Elements of the Strategy

The proposed strategy consists of six elements. Each element addresses an energy end-use, an end-user or end-user category and appropriate technical options for conservation or the use of renewables. These elements are described briefly here and in more detail in the main body of the report. They are not identified in order of priority.

Strategy Element A - Heat Recovery from Community Power Installations

This element of the strategy involves improving the efficiency of diesel community power through the use of waste heat for space heating.

Strategy Element B - Community Power - Development and Demonstration of Use of Renewables

This element involves undertaking a variety of policy, developmental and demonstration initiatives aimed at creating a basis for potential medium to long term implementation of renewable technologies for electricity generation.

Strategy Element C - Space Heating of Existing Schools and Teacherages in Native Communities

This element potentially involves: energy retrofitting DIAND schools and teacherages (the largest consumer of fuel oil for space heat in remote communities); the substitution of wood for oil in school heating systems; and, the recovery of heat for space heating from DIAND diesel sets.

Strategy Element D - Space Heating - New Institutional and Commercial Buildings Design

This element involves the development and dissemination of

design standards and guidelines for Northern remote buildings. It also includes the development of standardized modular designs for types of buildings which are widely required in these communities.

Strategy Element E - Residential Space Heating In Native Communities

This element addresses improved housing in terms of energy efficiency and broader socio-economic considerations. This is a high priority for Native communities. The recommended measures involve the transfer of information and technology to assist Bands to enable them to use existing housing programs to construct more energy efficient new housing and to upgrade the energy efficiency of existing housing.

Strategy Element F - Information and Technology Transfer for Rail Communities

This strategy element addresses the potential for improved energy efficiency in space heating in the remote rail communities in Ontario in terms of the commercial residential and institutional sectors.

Implementation Plan

An implementation schedule and plan is presented in the report. Most of the activities for the first 1-5 years relate to space heating. Electricity generation alternatives, particularly those involving biomass based systems are the subject of developmental and demonstration initiatives in the 1-5 year period, with more widespread implementation as a possibility in the 5-10 year period.

Organizational Implications

In the 1-5 year period no major organizational changes will be required to support the implementation of the strategy. In the medium to long run it is envisaged that, if biomass based electricity generation systems are shown to be ready for widespread application, there may be a need for a new delivery mechanism for electricity generation.

In the 1 - 5 year period it is recommended that a capability be developed by DIAND to provide practical advice to Native communities on energy matters. The focus of this advisory service to Bands would be on: ensuring that heat recovery options are given consideration in the planning of diesels installations or major upgrades; ensuring that the potential for use of waste heat from diesels is considered in the planning of new buildings; and, assisting Bands to develop more energy efficient and appropriate housing and to renovate existing housing for improved energy efficiency, within the constraints imposed by exisiting housing programs.

National Implications

In the view of the Study Team the major implications of the findings and recommendations of this report are as follows:

- Federal Government buildings, Native housing and Federal housing programs are much the same in remote communities across Canada -- the recommendations made in this report (Strategy elements 1,3 and 4) are therefore presumeably applicable in at least the four western provinces and Quebec.
- Many of the problems associated with the use of renewables to generate electricity would be common to the four western provinces and Quebec although some of the institutional arrangements are different -- the recommended cautious approach should therefore be applicable.
- The relative limitations noted in the report with regard to the scope for Federal action in non-Native remote communities would be applicable in the four western provinces and Quebec.

ENERGIES DE RECHANGE DANS LES COLLECTIVITES ELOIGNEES DE L'ONTARIO: STRATEGIE ET PLAN DE MISE EN OEUVRE

Résumé

Introduction et renseignements généraux

Ce document est le rapport final de l'étude entreprise par la DPA Consulting Limited et la Marbek Resource Consultants Ltd., pour le compte d'Energie, Mines et Ressources Canada, dans le cadre du Programme de démonstration dans les collectivités éloignées.

L'étude a pour objectif ce qui suit:

"Elaborer une stratégie et un plan de mise en oeuvre qui permettraient au gouvernement du Canada d'aider les collectivités éloignées de l'Ontario à réduire leur dépendance à l'égard des produits pétroliers, en utilisant d'autres ressources énergétiques et en faisant appel à des techniques et à des mesures d'économies de l'énergie."*

L'étude a clairement démontré que les établissements gouvernementaux étaient les principaux utilisateurs directs de combustibles fossiles. Les résidants utilisent une certaine quantité de combustibles fossiles pour le transport et la cuisine, mais se servent du bois pour chauffer les locaux, ce qui est leur principal besoin en énergie. L'équipe chargée de l'étude estime qu'il serait possible de répondre à certains des besoins des résidants grâce à une intervention au niveau de l'énergie, mais que certaines de ces possibilités ne peuvent être exploitées facilement dans le cadre d'une stratégie axée exclusivement sur la réduction de la consommation de produits pétroliers.

Il a donc été convenu avec le comité directeur de l'étude que la stratégie serait élargie de manière à répondre aux objectifs suivants:

- réduire la dépendance des collectivités éloignées à l'égard des combustibles fossiles;
- exploiter au maximum le potentiel d'économies d'énergie (bois et combustibles fossiles);
- maximiser la création d'emplois et le développement organisationnel résultant de la nécessité de fournir et d'économiser l'énergie; et,
- utiliser les possibilités d'approvisionnement et d'économie pour améliorer la gamme de services déjà offerts, les conditions et le mode de vie dans ces collectivités.

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*Aux fins de cette étude, une collectivité éloignée est définie comme une collectivité: qui compte plus de 10 foyers permanents; qui n'a pas accès au réseau de distribution de l'Ontario Hydro ou à un gazoduc; et dont la durée prévue est d'au moins cinq ans. Quarante et une collectivités de l'Ontario répondent à cette définition.

L'équipe chargée de l'étude a réalisé un programme de travail comprenant des consultations avec les fonctionnaires, un examen et une analyse des documents existants et un suivi avec les principaux fonctionnaires et les sources de données. Les membres de l'équipe ont aussi visité un certain nombre de collectivités éloignées et ont eu l'occasion de rencontrer des représentants de ces collectivités.

Pour analyser le contexte de la stratégie, l'équipe s'est servie des bases de données existantes pour déterminer:

- les modèles actuels et futurs de consommation d'énergie (utilisation finale et utilisateurs finals d'énergie);
- le potentiel en matière de ressources renouvelables; et,
- les options techniques en ce qui a trait à l'utilisation des ressources renouvelables et à l'économie de l'énergie.

Les paragraphes suivants résument les principales conclusions de l'étude, dans le contexte de la stratégie.

Contexte d'application de la stratégie

Consommation d'énergie

Les points suivants permettent de mieux saisir le contexte dans lequel la stratégie devrait être appliquée.

- Le bois représente 43 % du total de l'énergie consommée et est utilisé exclusivement pour le chauffage des locaux dans les résidences.
- L'essence et d'autres carburants (kérosène, propane, etc.) représentent 11 % (3 millions de litres) de la consommation totale d'énergie et sont principalement utilisés pour le transport, la cuisine, l'alimentation des petits moteurs, etc.
- Le mazout est de loin le plus important combustible fossile, puisqu'il représente 46 % (13 millions de litres) de la consommation totale d'énergie et est utilisé pour produire de l'électricité et chauffer les locaux.

Bien entendu, le chauffage des locaux (39,3 % ou 5 121 400 litres) et la production d'électricité (52,6 % ou 6 972 500 litres) s'avèrent les principales utilisations finales du mazout.

Etudions maintenant la consommation de mazout par utilisateur final ou groupe d'utilisateurs pour les deux principales utilisations finales, soit le chauffage des locaux et la production d'électricité. En ce qui a trait au chauffage des locaux, le Ministère des Affaires indiennes et du Nord du Canada (MAINC) consomme 41% du total (2 134 300 litres). Pour ce qui est de la production d'électricité, la consommation de l'Ontario Hydro atteint 59,7 % (4 160 000 litres) et celle du MAINC, 10,9 % (756 77 litres). Ces deux organismes sont donc les principaux utilisateurs finals de mazout. Dans le secteur résidentiel, l'utilisation finale du mazout est principalement limitée aux collectivités ferroviaires plus grandes et plus complexes.

Potentiel en matière de ressources renouvelables:

- Les collectivités éloignées de l'Ontario disposent d'abondantes ressources renouvelables qui mériteraient d'être prises en considération en tant que solution de rechange au mazout.

- Le bois et, dans le cas des collectivités côtières (baie d'Hudson et Grands Lacs), le vent sont deux ressources particulièrement importantes. Les ressources hydro-électriques, bien qu'elles soient limitées et que leur coût de mise en valeur soit très élevé, représente aussi une ressource locale importante.

- Bien qu'on estime que la tourbe soit une ressource relativement abondante, il faudrait obtenir de plus amples données avant de pouvoir effectuer une évaluation valable.

- L'énergie solaire pourrait servir au chauffage solaire passif et il serait possible d'utiliser de petites piles photovoltaiques.

Options techniques

L'équipe a établi que pour être intégrée à cette stratégie, une option technique devait avoir fait ses preuves au moins dans les collectivités centrales. Il ne resterait plus qu'à prouver qu'elle est applicable dans les collectivités éloignées. Le rapport conclut que:

- Il existe une grande variété d'options techniques quant à l'économie d'énergie et à l'utilisation des ressources renouvelables.

- Les options techniques relatives au chauffage des locaux (économie d'énergie) peuvent être appliquées dès maintenant.

- Les systèmes hybrides diesel/énergie éolienne sont presque prêts à être installés dans les collectivités éloignées où les vents sont assez forts. Les résultats d'un projet de démonstration entrepris à Coniston devraient paver la voie à un projet semblable dans une collectivité éloignée près de la baie James ou sur la côte de la baie d'Hudson.

- Les petites centrales hydro-électriques ont déjà fait leurs preuves, mais les coûts fixes élevés constituent un obstacle majeur, étant donné le processus décisionnel existant. Des études de faisabilité effectuées dans au moins deux collectivités éloignées ont démontré que ces petites centrales pourraient être économiquement intéressantes comparativement au diesel. Toutefois, aucun projet de ce genre n'a été réalisé. Par conséquent, il faudrait tout d'abord travailler à obtenir une décision voulant qu'en principe, lorsque la faisabilité de l'emplacement est démontrée, il soit possible d'obtenir du financement en capital.

- Les moteurs à vapeur ont déjà prouvé leur faisabilité, mais leur utilisation est limitée à cause de deux facteurs:

    - dans la majorité des applications (plus de 50kW), il faut qu'un mécanicien de machines fixes de quatrième classe surveille constamment le système; et,

  - le rendement de la conversion de la vapeur en électricité est relativement faible par rapport aux autres techniques de conversion. Pour obtenir un système efficace, il faut être capable d'utiliser la chaleur résiduaire pour chauffer l'eau ou les locaux.

- Les turbines à vapeur sont relativement efficaces et fiables. Toutefois, parce qu'elles fonctionnent à une pression élevée, elles sont généralement considérées comme étant trop complexes pour être utilisées dans des collectivités éloignées.

- La technologie des gazogènes se développe rapidement, mais ces dispositifs ne sont pas encore assez fiables pour être utilisé de façon autonome dans des collectivités éloignées.

- Les techniques de coupe du bois sont déjà au point, mais jusqu'à maintenant, aucune démonstration n'a été effectuée à l'échelle requise, dans une collectivité autochtone éloignée.

- Les techniques de récolte de la tourbe sont déjà commercialisées et sont très répandues en Europe, mais à une échelle beaucoup plus grande que ce qui serait nécessaire dans les collectivités éloignées de l'Ontario.

Approche relative à l'élaboration de la stratégie

L'équipe chargée de l'étude a tenté d'élaborer une stratégie qui permettrait d'équilibrer les initiatives visant à réduire la consommation de combustibles fossiles et celles visant à réaliser les objectifs sociaux et économiques de la stratégie et des collectivités éloignées. L'équipe a tenté d'identifier les initiatives auxquelles le gouvernement fédéral peut prendre une part active et qui assureraient une utilisation maximale des programmes existants.

Les modèles actuels et futurs de consommation d'énergie ont servi de point de départ à l'élaboration de la stratégie. L'équipe a dressé une liste des combinaisons d'utilisation finale de l'énergie et d'utilisateurs finals et a par la suite évalué leur importance dans le contexte de la stratégie, en fonction de leur potentiel en ce qui a trait à la réalisation des objectifs de la stratégie et des autres considérations mentionnées dans le paragraphe ci-dessus.

Cette évaluation a mené à un certain nombre de recommandations qui ont à leur tour permis d'élaborer les éléments de la stratégie. Globalement, l'équipe a fait les recommandations suivantes:

- la stratégie devrait mettre l'accent sur deux utilisations finales de l'énergie, soit le chauffage des locaux et la production d'électricité;

- même si le transport représente une part importante de la consommation de combustibles fossiles, les options techniques relatives à ce secteur (par exemple, conception de véhicule) vont au-delà des attributions de cette étude;

- les mesures qui donneraient les résultats les plus probants à court terme sont les mesures d'économie de l'énergie utilisée pour chauffer les locaux et la récupération de la chaleur produite par les centrales alimentées au diesel; et,

- à moyen et à long termes, la production d'électricité au moyen des énergies renouvelables pourrait contribuer considérablement à la réalisation des objectifs, mais seulement si d'autres travaux de développement sont effectués.

La rapport comprend des recommandations plus détaillées.

Eléments de la stratégie

La stratégie proposée comprend six éléments. Chacun de ces éléments porte sur une utilisation finale de l'énergie, un utilisateur final ou une catégorie d'utilisateurs finals et donne les options techniques pertinentes quant aux économies d'énergie et à l'utilisation des énergies renouvelables. Ces éléments sont décrits brièvement ici et sont donnés plus en détails dans le rapport. Ils ne sont pas énumérés par ordre de priorité.

Elément A - Récupération de la chaleur produite par les installations de production d'électricité.

Cet élément de la stratégie nécessiterait l'amélioration du rendement des centrales alimentées au diesel, grâce à l'utilisation de la chaleur résiduaire pour le chauffage des locaux.

Elément B - Electricité - Mise en valeur et démonstration de l'utilisation des énergies renouvelables.

Cet élément nécessiterait la mise en oeuvre de diverses politiques et initiatives en matière de démonstration et de mise en valeur sur lesquelles serait fondée la mise en application potentielle des techniques de production d'électricité au moyen d'énergies renouvelables.

Elément C - Chauffage des écoles et des résidences des professeurs dans les collectivités autochtones.

Cet élément comprend: l'amélioration du rendement énergétique des écoles et des résidences des professeurs qui appartiennent au MAINC (le plus grand consommateur d'énergie destinée au chauffage des locaux dans les collectivités éloignées); le remplacement du mazout par le bois dans les systèmes de chauffage des écoles; et, la récupération de la chaleur produite par les installations du MAINC alimentées au diesel.

Elément D - Chauffage des locaux - Conception de nouveaux immeubles commerciaux et de nouveaux établissements.

Cet élément comprend l'élaboration et la diffusion de normes et de directives en matière de conception d'immeubles dans les collectivités éloignées du Nord. Il comprend aussi l'élaboration de plans normalisés de divers types d'immeubles dont ces collectivités ont besoin.

Elément E - Chauffage des locaux résidentiels dans les collectivités autochtones.

Cet élément a pour but d'améliorer le rendement énergétique des maisons et tient compte des considérations socio-économiques. Il doit être appliqué en priorité dans les collectivités autochtones. Les mesures recommandées comprennent le transfert de l'information et de la technologie afin d'aider les bandes à utiliser les programmes d'habitation existants pour construire des maisons à rendement énergétique élevé et à améliorer l'efficacité des maisons existantes.

Elément F - Transfert de la technologie et de l'information dans les collectivités ferroviaires.

Cet élément traite du potentiel d'amélioration du rendement énergétique des immeubles dans les secteurs résidentiel, commercial ou autres, dans les collectivités éloignées de l'Ontario.

Plan de mise en oeuvre

Ce rapport comprend un calendrier et un plan de mise en oeuvre. La majorité des activités des cinq premières années portent sur le chauffage des locaux. Les mesures relatives à la production d'électricité, particulièrement celles relatives à l'énergie biomassique, devront faire l'objet de démonstrations au cours d'une période d'un à cinq ans, et seront appliquées de façon plus répandue au cours d'une période de cinq à dix ans.

Répercussions sur l'organisation

Au cours de la période d'un à cinq ans, la mise en oeuvre de la stratégie ne nécessitera aucun grand changement organisationnel. A moyen et à long termes, il est toutefois prévu que, si les appareils de production d'électricité alimentés à la biomasse s'avèrent prêts à être utilisés plus couramment, il faudra peut-être établir une nouvelle méthode d'application du programme en ce qui a trait à la production d'électricité.

Au cours de la période d'un à cinq ans, il est recommandé que le ministère des Affaires indiennes et du Nord du Canada s'organise pour être en mesure de donner des conseils pratiques aux collectivités autochtones sur les questions relatives à l'énergie. Ce service consultatif destiné aux bandes permettrait: de s'assurer que les mesures de récupération de la chaleur sont prises en considération lorsque l'on se propose de construire des installations alimentées au diesel ou que l'on projette des améliorations majeures; de s'assurer que le potentiel d'utilisation de la chaleur résiduaire produite par les moteurs diesel est pris en considération lors de la planification de nouveaux immeubles; et, d'aider les bandes à mettre au point des maisons à rendement énergétique élevé et à rénover les maisons existantes de manière à en augmenter le rendement énergétique, dans les limites imposées par les programmes d'habitation existants.

1.0 INTRODUCTION

1.1 THE STUDY

This is the final report of a study entitled Energy Alternatives for Ontario Remote Communities: A Strategy and Implementation Plan. The study was undertaken by DPA Consulting Limited and Marbek Resource Consultants Ltd. on behalf of Energy, Mines and Resources Canada as part of the Remote Community Demonstration Program.

The high cost of energy in Ontario's remote communities* as well as the growing demand by remote community residents for improved living standards - electricity service, improved housing quality, economic development etc. - has precipitated a significant number of recent energy studies and demonstration projects. In fact, this present study, initiated under the Remote Community Demonstration Program, is proceeding concurrently with several related initiatives.

The broad intent of this study is to use the existing and developing body of knowledge to recommend to the Federal Government a short-term and long-term strategy and implementation plan for reduction of the dependence of Ontario's remote communities on high-cost, non-renewable fossil fuels.

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*For this study, a remote community is defined as:

- . having 10 or more permanent households; and,
- . not having access to the Ontario Hydro grid or a gas pipeline.
- . Appendix A presents a list of the remote communities in Ontario.

1.2 STUDY OBJECTIVES

The purpose of this study is:

> "To develop a strategy and implementation plan for the Government of Canada for reduction of dependence on petroleum in remote communities in Ontario, through the utilization of alternate energy resources and technologies and energy conservation measures."

During the course of the study it became evident that the major users of petroleum products in the communities are government institutions. Consequently, a strategy focussing exclusively on reducing petroleum use would not address opportunities for conservation, economic development and lifestyle improvement among local residents. The scope of the study was therefore broadened to include energy related activities which would address these opportunities. Thus initiatives which would not result in direct reduction of dependence on petroleum, such as measures to reduce the amount of wood used in space heating, could be included in the strategy if they yielded economic opportunities and/or improvements to living standards.

The principal questions to be addressed in the study included:

- Where can the greatest energy savings be achieved through which specific technologies?
- How can energy conservation measures and the available renewable energy resources be used to improve socio-economic conditions in the community?
- What are the residents of these remote communities interested in doing or prepared to do in regard to energy alternatives or conservation given the prevailing socio-economic conditions and the incentives and disincentives facing them?

- What should Federal institutions such as DIAND and EMR be doing in pursuit of the objectives of the strategy?

The objectives of the strategy as agreed to by the client group for this study are as follows:

- to reduce dependence on fossil fuels in the remote communities;
- to maximize the potential for energy conservation (both wood and fossil fuels);
- to maximize the job creation and organizational development potential arising from the need to supply and/or conserve energy; and,
- to use the supply and conservation opportunities to enhance the range of services available, living conditions and life-styles in the communities.

It is understood that these objectives are within the context of broader objectives of the two levels of government with regard to the provision of services such as electricity in these communities.

1.3 APPROACH

Exhibits 1.1 and 1.2 outline the approach and the model employed by the Study Team in developing the strategy and implementation plan. As shown in these exhibits, the study has been divided into 3 stages:

- . Data Assembly and Analysis
- . Identification of Opportunities
- . Strategy Definition

The data used in this study were derived from four principal sources:

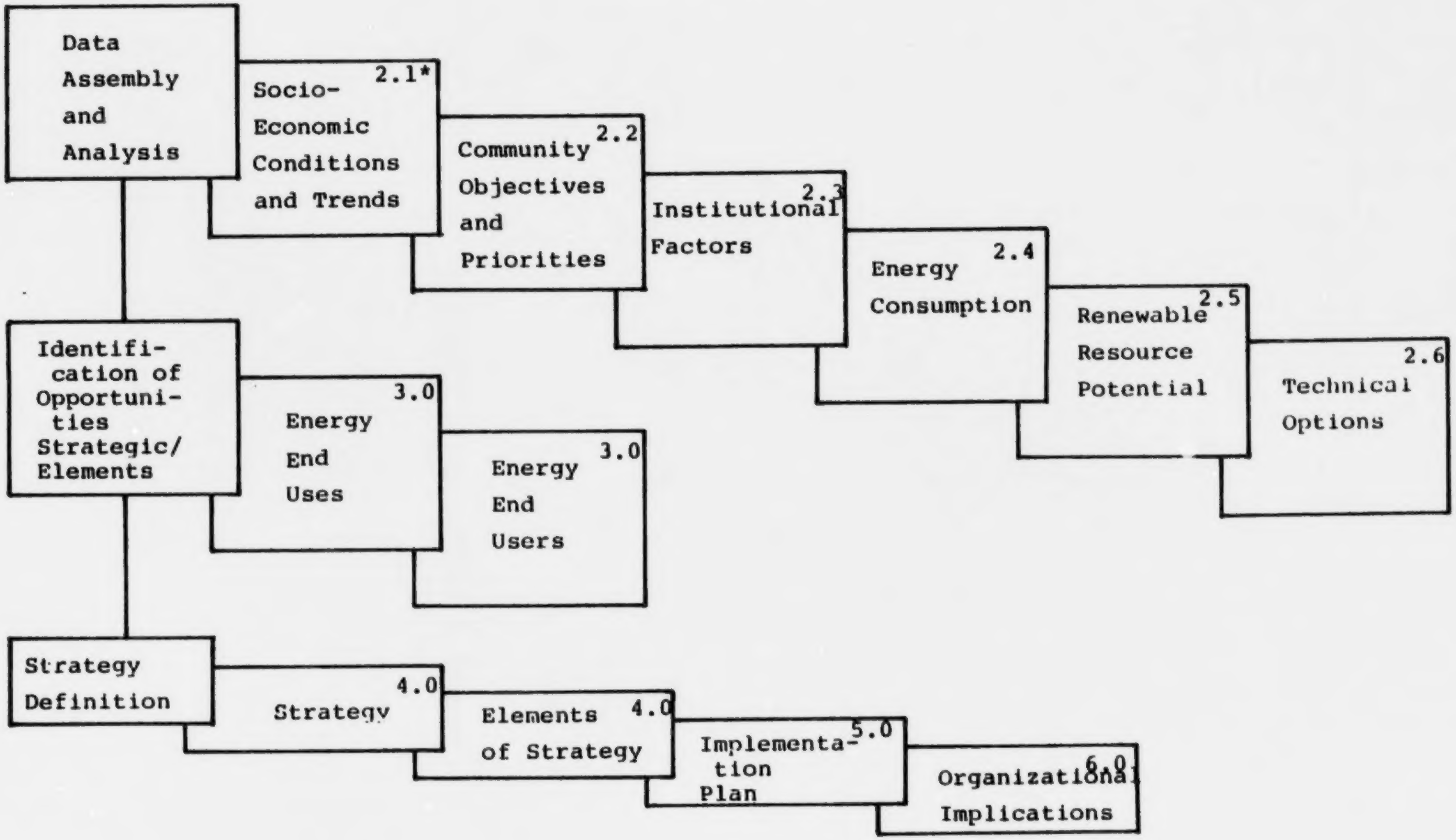
- . existing energy and resource data bases;
- . consultation with staff in both Federal and Provincial agencies responsible for the delivery of services in remote communities;
- . consultations with selected remote community residents in their communities; and,
- . applicable technology development and renewable resource assessment studies and reports.

In addition, the Study Team was able to draw on its own experience in developing energy alternatives in Ontario remote communites.

The subject areas identified in Exhibit 1.1 under data Assembly and Analysis are those which the Study Team considered to be critical to the development of the strategy. These areas were previously addressed in the progress report for this study. Section 2 of this report provides a summary of these data; further detail is provided in Appendices B, C, D and E.

EXHIBIT 1.1

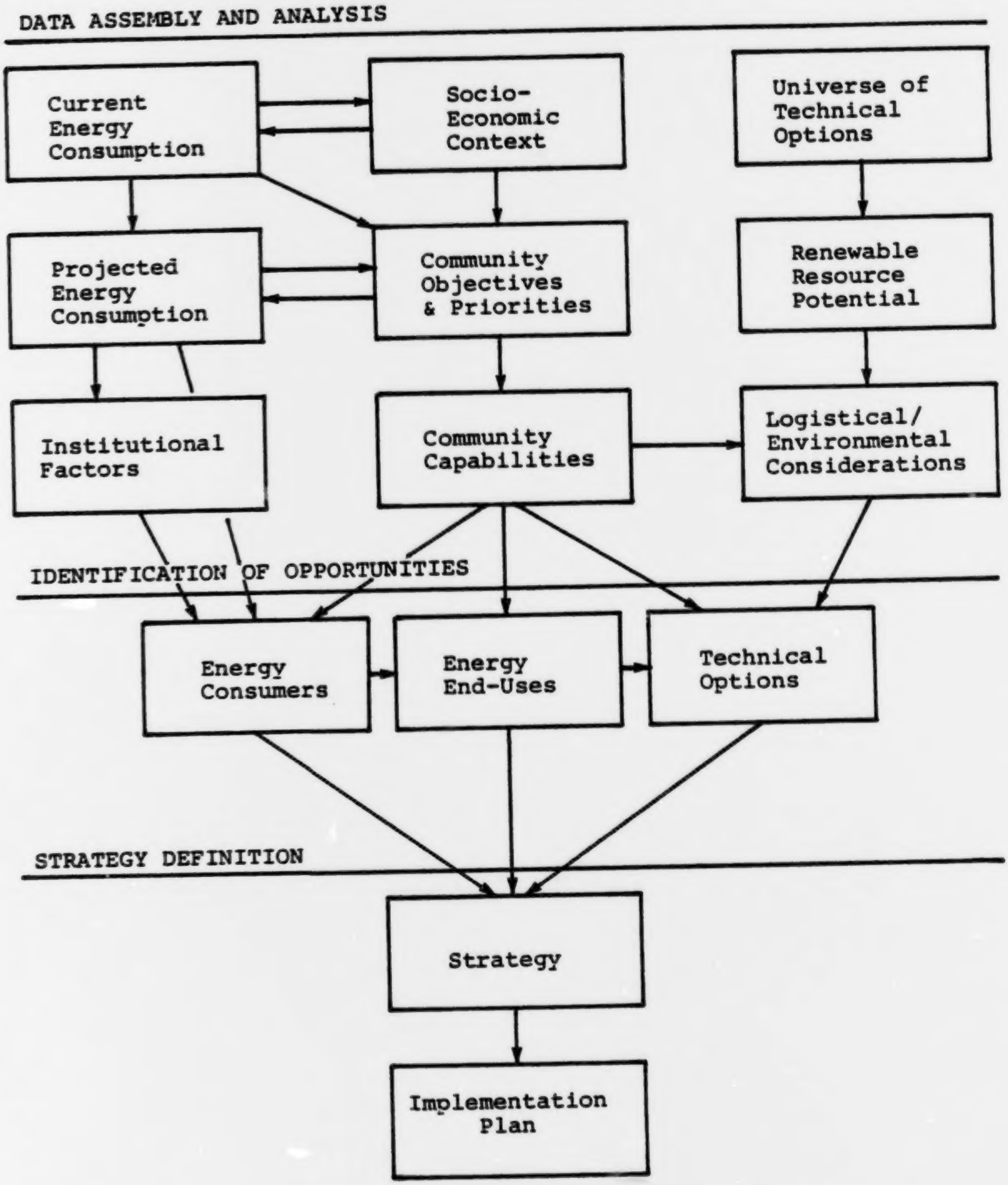
APPROACH


Data Assembly and Analysis
Socio-Economic Conditions and Trends 2.1*
Community Objectives and Priorities 2.2
Institutional Factors 2.3
Energy Consumption 2.4
Renewable Resource Potential 2.5
Technical Options 2.6
Identification of Opportunities Strategic/ Elements
Energy End Uses 3.0
Energy End Users 3.0
Strategy Definition
Strategy 4.0
Elements of Strategy 4.0
Implementation Plan 5.0
Organizational Implications 6.0

* Refers to relevant Report Chapters

EXHIBIT 1.2

LOGIC MODEL


DATA ASSEMBLY AND ANALYSIS
Current Energy Consumption
Socio-Economic Context
Universe of Technical Options
Projected Energy Consumption
Community Objectives & Priorities
Renewable Resource Potential
Institutional Factors
Community Capabilities
Logistical/ Environmental Considerations
IDENTIFICATION OF OPPORTUNITIES
Energy Consumers
Energy End-Uses
Technical Options
STRATEGY DEFINITION
Strategy
Implementation Plan

Section 3 of this report identifies the main opportunities for the implementation of energy conservation and renewable energy options in the study communities. These conclusions are derived from analysis carried out in the initial step of the study and provide the basis for defining the strategy and implementation plan that is presented in Sections 4, 5, and 6.

2.0 DATA ASSEMBLY AND ANALYSIS

2.1 SOCIO-ECONOMIC CONTEXT

Exhibit 2.1. is a map showing the location of Ontario's 41 remote communities. For the purposes of this study, the most important distinction is between two groups of remote communites:

. Native Communities

. Rail Communities

These two groups are briefly described in the following sections. More detailed profiles are provided in Appendix B.

2.1.1. Native Communities

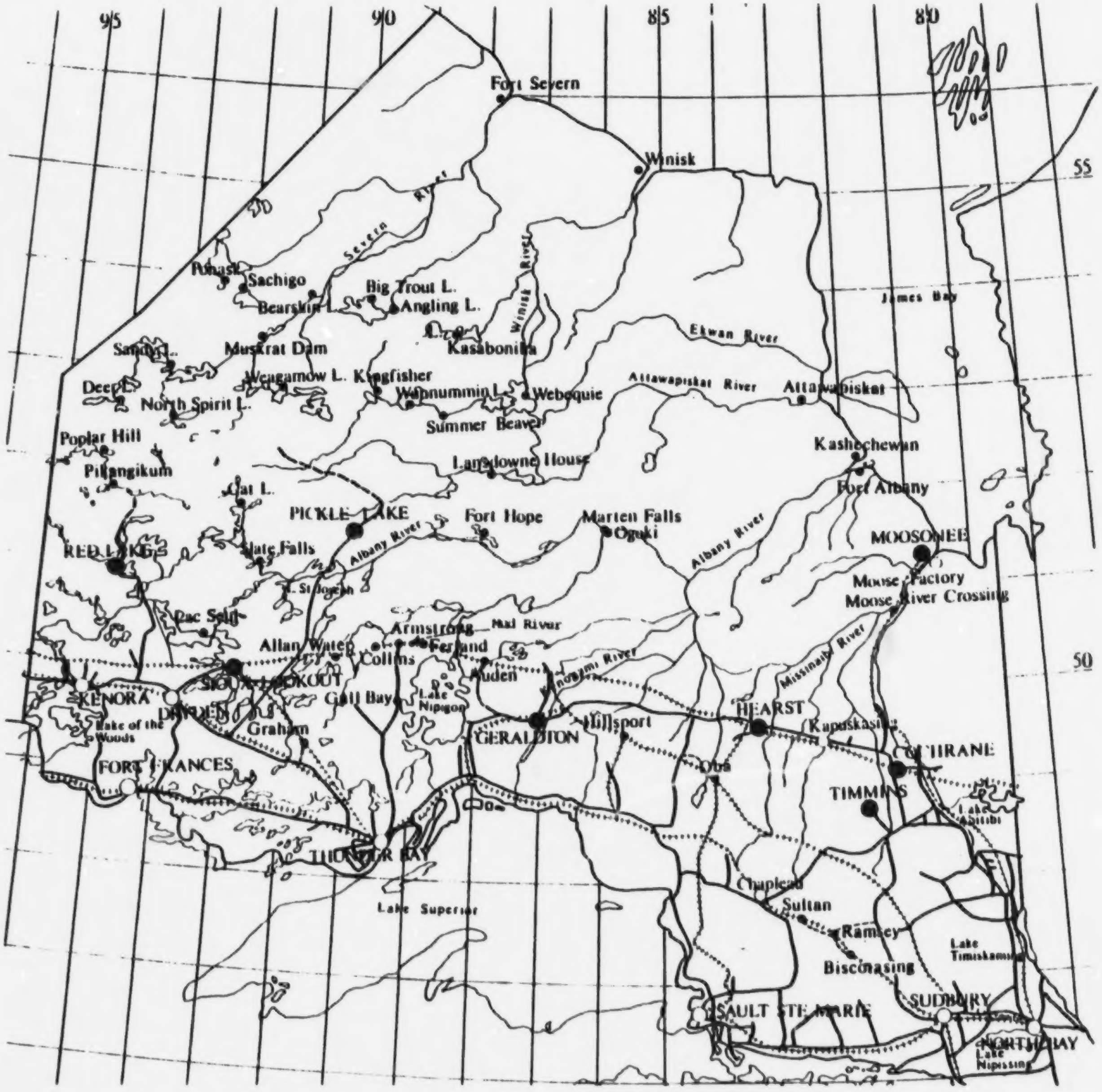
There are 28 remote Native communities included in this study. The total population is approximately 13,000 living in an estimated 2730 households. There is significant variation in both the size and in the level of services available. On one end of the scale is the community of Sandy Lake, which has a population of 1344, and contains a wide range of facilities and services (eg. school, nursing station, community power, local telephone exchange, scheduled air service etc). On the other end of the scale is the community of Slate Falls which has a population of about 70 - 80, and only very limited facilities.

Native communities are distinguished from rail communities by:

. the administative framework from which they operate (see Section 2.3);

. the social/cultural characteristics (although most rail communities have large non-status Indian populations); and,

Exhibit 2.1:
Map of Communities


95
90
85
80
55
50
Fort Severn
Winisk
Severn River
Winisk River
Poplar Hill
Sachigo
Big Trout L.
Bearskin L.
Angling L.
Kasabonika
Sandy L.
Muskrat Dam
Deer L.
Weagamow L.
Kingfisher
Wunnummin L.
Webequie
North Spirit L.
Summer Beaver
Poplar Hill
Pikangikum
Lansdowne House
Cat L.
PICKLE LAKE
Fort Hope
Marten Falls
Ogoki
Albany River
RED LAKE
Slate Falls
St. Joseph
Pac Seul
Allan Water
Armstrong
Ferland
Nal River
Collins
Auden
Kenogami River
Missinaibi River
SIOUX LOOKOUT
KENORA
DRYDEN
Gull Bay
Lake Nipigon
Graham
Lake of the Woods
GERALDTON
Hillsport
HEARST
Kapuskasing
COCHRANE
FORT FRANCES
Oba
TIMMINS
Lake Abitibi
THUNDER BAY
Lake Superior
Chapleau
Sultan
Ramsey
Biscotasing
Lake Timiskaming
SAULT STE. MARIE
SUDBURY
NORTH BAY
Lake Nipissing
Ekwan River
Attawapiskat River
Attawapiskat
James Bay
Kashechewan
Fort Albany
MOOSONEE
Moose Factory
Moose River Crossing

Study Communities
Supply Centres
Other Major Centres
Highways
Gravel or seasonal road
Railways
SCALE 1:4 000 000
mi 50 100
km 100 200

- they are accessible only by air whereas all rail communities have access by rail and some are accessible by road.

There are dangers in generalizing because of the wide variations among Native communities. However, the following points are relevant for all Native communities to some degree or another.

These communities exist as a juxtaposition of a traditional nomadic hunting and gathering society, on the one hand and a dynamic, aggressive and technologically advanced society, on the other hand. In these remote communities, this juxtaposition has come about largely during the last 50 years, and has resulted in a traumatic and often difficult period of adjustment. Key considerations are:

- the abandoning of nomadic lifestyles eliminated the potential for sustenance through traditional economic activity for most residents;

- new economic activities have not yet replaced the traditional economic activities;

- population growth, has resulted from improved medical facilities and reduced infant mortality as well as increased numbers of returning young people; and,

- population pressures and relatively low levels of economic activity have resulted in extensive dependence on the Federal Government both at the personal and community levels.

The result is that some communities have serious social problems and all of the communities have serious unemployment. In general, organizational skills, technical skills, education and work experience are limited. On the other hand, some communities have made considerable progress in recent years in terms of taking charge of their own destinies and have begun to address social problems and economic opportunites.

2.1.2 Rail Communities

The rail communities consist of 13 isolated communities located along the CN Rail, CP Rail and Ontario Northland Railway in Northern Ontario. With the exception of Armstrong (population 800), they are generally unorganized communities with permanent populations of less than 200. They have developed as service points for the rail line and/or as centers for local timber cutting operations. In a few cases, seasonal tourism activities remain an important aspect of the local economy. Much of the population is non-Status Indian or Metis, although in some cases there is a large non-Native population. Because neither the communities nor their Indian and Metis inhabitants have official Indian Status, no special relationships exist with the Federal Government.

There is a wide divergence among the remote rail communities with respect to facilities, services, energy-use patterns and socio-economic conditions. The community of Armstrong represents one end of the scale in that:

- it has a population of about 800 residents, of which non-Native residents compose the majority;
- private sector activity is well developed;
- it has well developed transportation links to Thunder Bay (approximately a 3-hour drive over a well maintained road);
- the available labour force has a much higher skill level than in most other remote communities and is thoroughly familiar with the operation and maintenence of heavy equipment; and,

- energy use patterns resemble those found in non-remote communities (widespread use of automobiles and trucks, most residences have hot water, sewage systems, electricity and conventional central heating systems).

With variations, comparable conditions are also found in Ramsey, which is the centre of E. B. Eddy Forest Products Ltd.'s forest harvesting operations for its pulp and paper mill in Espanola.

At the other end of the scale are communities such as Mud River which has 10 permanent residences but the range of organizational and technical skills is inevitably somewhat limited.

2.2 COMMUNITY OBJECTIVES AND PRIORITIES

In the case of Native communities the objectives and priorites vary widely from community to community. However, in broad terms energy related priorities include:

- access to community electricity where it does not now exist;
- access to levels of service higher than currently available;
- reduced energy costs;
- opportunities for creating employment and economic development through energy production from renewables or through construction employment in conservation projects;
- improvements to living conditions through more comfortable homes and community buildings; and,
- particularly for some of the more northern or coastal communities, reduced pressure on wood supplies.

The priorities for rail communities would not be particularly different in most cases although the communities tend to be less cohesive and have less in the way of formal institutional and organizational structure.

2.3 INSTITUTIONAL CONSIDERATIONS

At present the Federal Government, principally through the Department of Indian Affairs and Northern Development (DIAND), plays an important role in the use of fossil fuels in the Native communities (see Sections 2.4 and 3.4). The Federal Government has a unique relationship with Status Indians, individually and collectively, and assumes many of the administrative and financial responsibilities normally handled by the Province and local government.

The Province, and its agencies, such as Ontario Hydro, have ambivalent relationships with these communities. The Ontario Government has accepted responsiblity for a range of services to these communities under a General Welfare Agreement with the Federal Government which provides for reimbursement. Ontario has also provided other services under a variety of Ministries and agencies. Recognizing that Ontario Ministries were making ad hoc arrangements to provide services at an increasing pace during the 1960's and early 1970's, and wishing to establish overall control in this process, the Ontario Cabinet ruled some years ago that all new services or initiatives on reserves must have explicit Cabinet approval.

Band councils have had a degree of autonomy in priority setting and decision-making, but within relatively well-defined boundaries, established by DIAND. However, this relationship is changing and the policy of the Federal Government is now to allow and encourage Indian self-government to develop. While the specific long-run implications of this are not clear, it is generally expected that fundamental decision-making and responsibility for most aspects of community life on reserves will pass from the Federal Government to the Bands. This change could have significant implications for the strategy in the long run, but in view of the uncertainties surrounding such a shift at present, the strategy has been prepared based on the present institutional framework.

Regarding the existing institutional framework, the mandates, objectives, priorities and decision-making criteria of the key institutions are as important to the strategy in the short run as the objectives and priorities of the Bands. The key energy consuming institutional actors in the Native communities are: DIAND, Health and Welfare Canada (NHW), Ontario Hydro and the Ontario Ministry of Transportation and Communications (MTC). These institutions have important roles both as consumers or providers of energy in the communities and as policy makers. Any strategy which ignored their priorities and decision-making roles would have little chance of succeeding.

Institutions play a major role in the rail communities as well, although no one organization has the broad responsibilities for these communities, as has DIAND for the Native communities. The Ontario Government through Ontario Hydro, the Department of Education, the Ministry of Northern Affairs, the Ministry of Transportation and Communication and the Ministry of Energy has the major role in terms of decision-making in the energy sphere and direct consumption of fossil fuels.

2.4 ENERGY CONSUMPTION PATTERNS

Exhibit 2.2, an "energy spaghetti chart" provides an overall summary of the energy consumption patterns of remote communities in 1981*.

Total energy consumption (1981) including renewables in Ontario remote communities was approximately 1 million gigajoules (approximately equivalent to 28.5 million litres of fossil fuel).

Exhibit 2.2 shows the major fuel types, end use applications and users or user groups. Several observations are particularly important:

- Native communities account for 75% of total energy consumption in Ontario remote communities; and,

- Two end-uses, space heating (60%) and diesel electricity generation (24%) account for the ovewhelming bulk (84%) of total energy consumption including wood.

Exhibit 2.3 shows energy consumption by fuel type. The following points are very important in providing the context for the strategy.

- Wood accounts for 43% of total energy consumption and is used exclusively for residential space heating.

- Gasoline and other fuels (kerosene, propane, etc.) account for 11% of total energy consumption, and are used for transportation, cooking, small motors, and etc.

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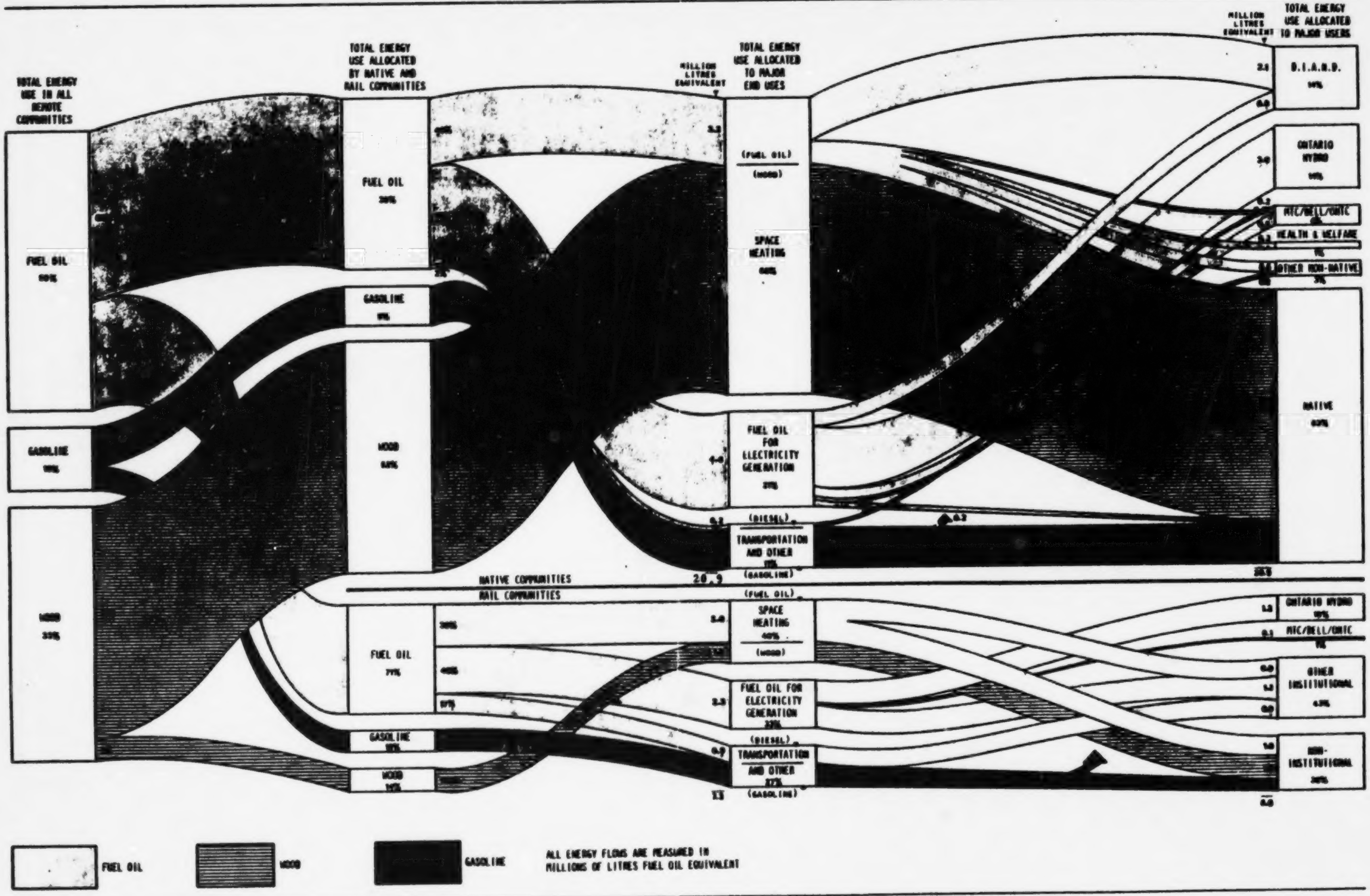
*The principal sources of data were reports prepared for the Ontario Ministry of Energy: The remote Community Data Base (September 1982) and Northern Community Energy Assessments Data (September 1982). Both studies report fuel consumption for 1981.

EXHIBIT 2.2:

SCHEMATIC DIAGRAM OF ENERGY FLOWS IN ONTARIO REMOTE COMMUNITIES


TOTAL ENERGY USE IN ALL REMOTE COMMUNITIES
FUEL OIL
GASOLINE
WOOD
TOTAL ENERGY USE ALLOCATED BY NATIVE AND RAIL COMMUNITIES
FUEL OIL
GASOLINE
WOOD
NATIVE COMMUNITIES
RAIL COMMUNITIES
FUEL OIL
GASOLINE
WOOD
MILLION LITRES EQUIVALENT
TOTAL ENERGY USE ALLOCATED TO MAJOR END USES
(FUEL OIL)
(WOOD)
SPACE HEATING
FUEL OIL FOR ELECTRICITY GENERATION
(DIESEL)
TRANSPORTATION AND OTHER
(GASOLINE)
20.9
(FUEL OIL)
SPACE HEATING
40%
(WOOD)
FUEL OIL FOR ELECTRICITY GENERATION
(DIESEL)
TRANSPORTATION AND OTHER
(GASOLINE)
13
MILLION LITRES EQUIVALENT
TOTAL ENERGY USE ALLOCATED TO MAJOR USERS
D.I.A.N.D.
ONTARIO HYDRO
MTC/BELL/ONTC
HEALTH & WELFARE
OTHER NON-NATIVE
NATIVE
ONTARIO HYDRO
MTC/BELL/ONTC
OTHER INSTITUTIONAL
NON-INSTITUTIONAL
FUEL OIL
WOOD
GASOLINE

ALL ENERGY FLOWS ARE MEASURED IN MILLIONS OF LITRES FUEL OIL EQUIVALENT

EXHIBIT 2.3: ENERGY CONSUMPTION BY FUEL TYPE*

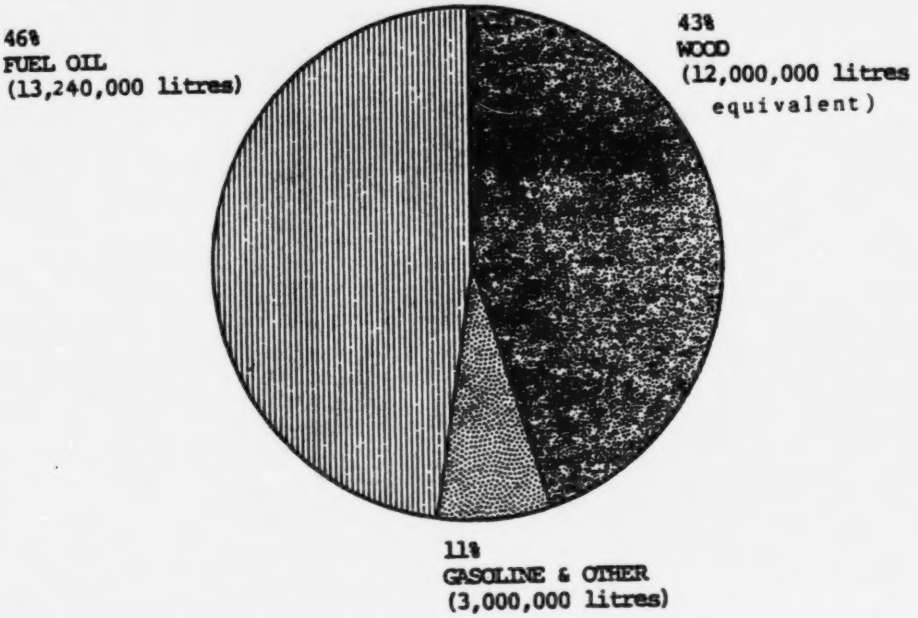
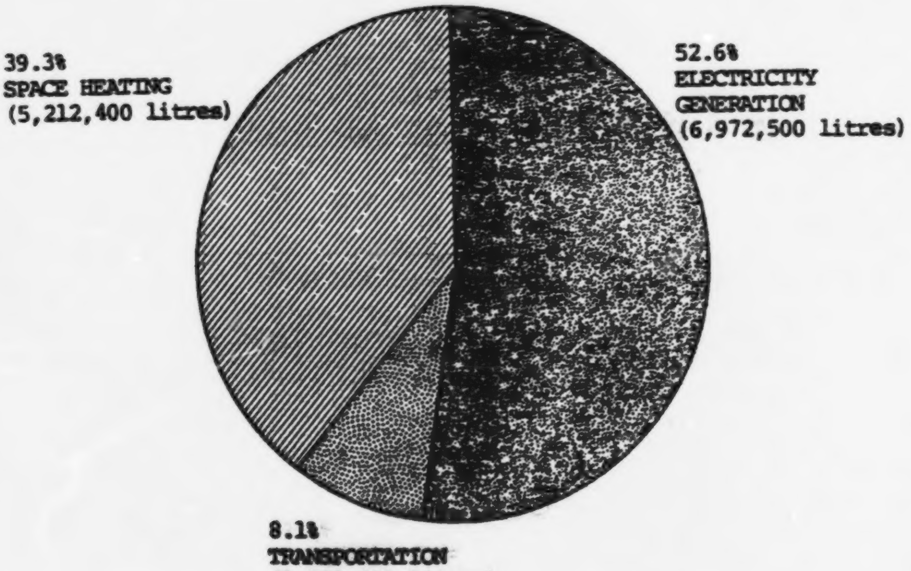
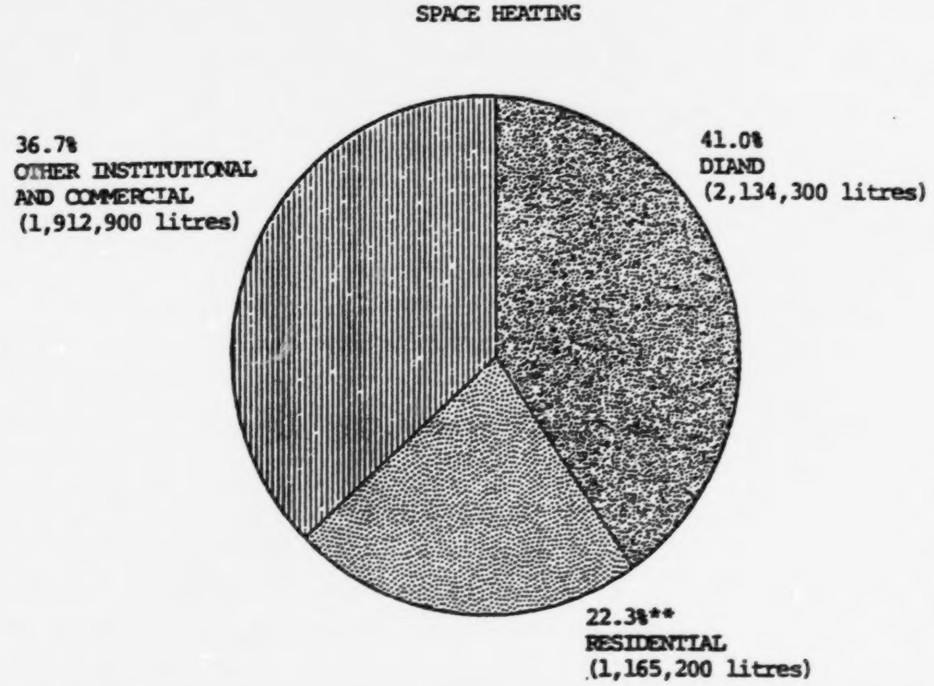


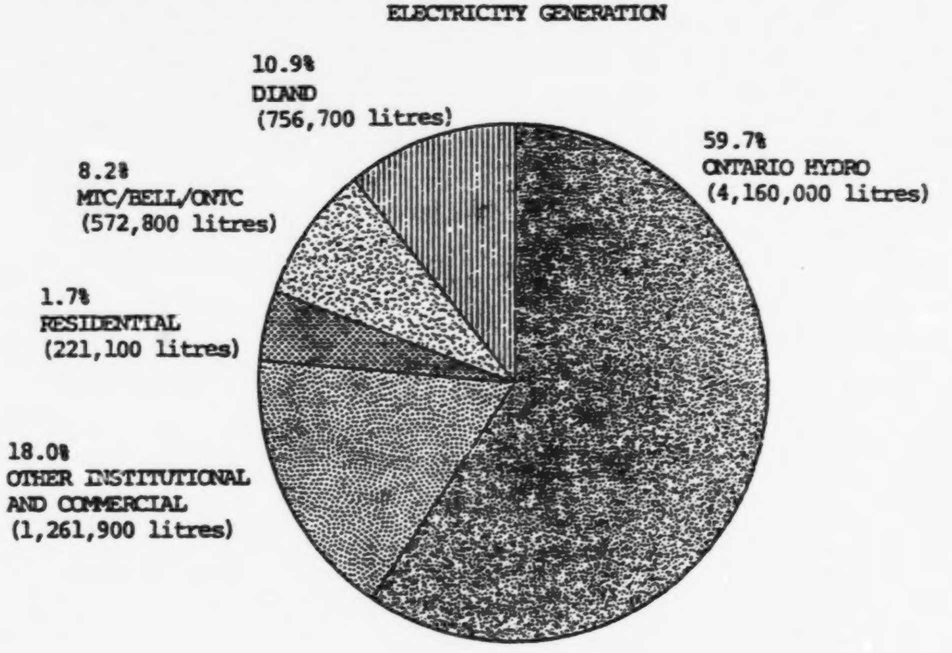
EXHIBIT 2.4: FUEL OIL CONSUMPTION BY END-USE



*Source: Remote Communities Data Base, Ontario Ministry of Energy, 1982.

EXHIBIT 2.5: FUEL OIL CONSUMPTION BY END-USER
THE TWO MAJOR END-USES (1981)*





* Source: The Remote Community Data Base, Ontario Ministry of Energy, 1982
** Primarily Armstrong and Ramsey Residents

- Fuel oil is by far the most important fossil fuel, accounting for 46% of all energy consumption and is used largely for electricity generation and space heating.

Exhibit 2.4 shows fuel oil consumption by end-use category. Clearly, space heating (39.3%) and electricity generation (52.6%) are the most important end-uses for fuel oil.

Exhibit 2.5 shows fuel oil consumption by end-user or end-user group for the two major end-uses, space heating and electricity generation. Ontario Hydro and the Department of Indian Affairs and Northern Development (DIAND) stand out as major end-users of fuel oil. The residential end-use of fuel oil is largely confined to the larger and more sophisticated rail communities.

It should be noted that in addition to the fuel types and end-uses shown in Exhibit 2.2, limited amounts of other liquid fuels -- propane, naptha and kerosene -- are used for cooking and lighting. With the exception of Armstrong, the quantities involved are considered to be quite small (1 - 3% of total consumption); however, reliable data are not available for most remote communities. In Armstrong about 100,000 litres of propane are consumed for cooking, hot water and space heating. Inasmuch as consumption of propane is significant in only this one study community, it is not considered separatley within the overall strategy.

2.5 RENEWABLE RESOURCES AVAILABILITY

Appendix D to this report is a table summarizing the renewable resource potential in each community. The data presented in Appendix D and in the summary comments on renewable resources provided here are drawn from existing documentation.* In many cases the only way to determine with absolute confidence the resource potential is through on-site assessments which are beyond the scope of this study. There are several studies proceeding concurrently with this study that will provide more detailed information on some of the most promising sites for biomass based systems.**

Wood

Wood provides almost 100% of residential space heating requirements in all Native communities and provides about 41% of the total space heating demand in rail communities. In most communities the current supply of wood is adequate and is sufficient to meet additional demands such as institutional space heating and electricity generation. In other communities, however, the resource would not be able to meet additional demands without a reduction in residential consumption or harvesting for both purposes over a larger area.

Small Scale Hydro

Adequate water flow and head characteristics sufficient to permit the use of small scale hydro exist close to approximately one fifth of the remote communities. Each of these potential sites have been given a preliminary assessment in previous Ontario Hydro studies. Based on these previous Ontario studies, 6 Native communities and 3 rail communities appear to have good potential for small scale hydro development. Feasibility studies have been carried out on five of the sites. Sultan is the location of the only remote micro hydro development to date.

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*Northern Community Energy Assessments Data (September 1982) and The Remote Community DAta (September 1982), Ontario Ministry of Energy.

**A study of the best sites for biomass based generation systems is being conducted for the Ontario Ministry of Energy (MOE) and EMR. A second study under the RCDP is exploring the potential for a peat-based electricity generation system at Cat Lake, Ontario with the participation from EMR, DIAND and MOE.

Peat

Peat deposits are widespread in Northern Ontario and are most accessible north of the tree line. The potential for use in a remote community depends primarily on the proxmity to an accessible deposit, how easily the deposit can be drained and harvested, and the size of the community to be served. A detailed assessment of peat deposits including aerial photo interpretation and core sampling is being carried out under a separate study for the Ministry of Natural Resources.

Wind

Wind speeds in Ontario are generally low except in coastal areas along Hudson Bay and the Great Lakes. Five remote communities along Hudson Bay have high enough average wind speeds (>5m/s at 10 m height) suitable for electricity generation. Several other communities within 300 km of Hudson Bay have marginal wind regines (wind speed 3 - 4 m/s at 10 m height).

The Ontario Ministry of Energy is conducting a demonstration wind/diesel hybrid project at Coniston. In addition, a detailed assessment of the wind resource of coastal communities is being made by Ontario Hydro.

Solar

Northern Ontario experiences long periods of clear weather in both summer and winter. Snow cover in winter also increases the amount of solar radiation falling on a tilted surface by a significant amount. The amount of useful radiation available to remote communities in Northern Ontario varies little between one community and another and between summer and winter. The daily radiation falling on a south facing surface tilted 60 degrees to the horizontal will vary between about 10 MJ/m2 in January and about 15 MJ/m2 in July. Average ambient temparatures can be expected to be about minus 20 degrees Celsius in January and +15 degrees Celsius in July.

It is clear that the available supply of renewable resources in Ontario remote communities is significant and merits serious consideration as a substitution option.

Wood fuel and, in the case of the coastal communities, wind are two particularly important resources. Micro-hydro resources, though restricted in their availability and subject to high development costs, also represent an important local source.

Solar resources are adequate for passive solar heating applications as well as small-scale photovoltaic applications.

2.6 TECHNICAL OPTIONS

2.6.1 The Range of Technical Options Considered

On the basis of the energy consumption patterns shown in Section 2.4, it is evident that two end uses dominate energy demand in Ontario remote communities. These are space heating and electricity generation. For each of these end-uses, technical options were identified and categorized by sector. The range of technical options considered is presented below:

A. **Space Heating**

I. Residential:

1. Improving insulation and air tightness in existing residences
2. Building new residences to high energy efficient standards
3. Installing high efficiency wood stoves in existing and new residences

II. Institutional/Commercial:

4. Improving insulation, furnace efficiency, and air tightness in existing institutional and commercial buildings
5. Building new institutional and commercial buildings to high energy efficiency standards
6. Installing wood/oil combination furnaces or boilers in existing and new institutional and commercial buildings

7. Utilizing waste heat from institutional/commercial private electrical generating sets in existing or new buildings for space or water heating in these buildings (cogeneration)

8. Utilizing waste heat from existing or new community power electrical generating systems for space or water heating in existing or new institutional or commercial buildings

B. Electricity

I. Communications:

9. Replacing existing diesel generating sets in stand alone communication facilities with cycle charge diesel generation sets

10. Installing wind/diesel hybrid generating systems in stand alone communications facilities

11. Installing photovoltaic/diesel hybrid diesel generating systems in stand alone communications facilities

II. Community Power:

12. Installing wind/diesel hybrid community power generating systems

13. Installing small scale hydro community power generating stations

14. Installing wood/gas diesel fuel internal combustion engine community power generating systems

15. Installing wood (fuel oil back up) fired steam engine community power generating stations

16. Installing wood (fuel oil back up) fired steam, gas, or organic Rankin cycle turbine community power generating systems

17. Installing peat (fuel oil back up) fired steam, gas, or organic Rankin cycle turbine community power generating system.

2.6.2 Technical Options - Summary of Status

The technical options identified in Section 2.6.1 for space heating (options 1 - 8) are all proven and can be implemented immediately wherever site conditions are suitable.

The technical options for alternative eletricity generation are (options 9 - 17), however, more complex.

- Wind-diesel hybrid systems are very close to being ready for application in those communities where wind regimes are adequate. The results of a demonstration project at Coniston should prepare the way for a demonstration project at a remote Native community on the James Bay coast.

- Small scale hydro is a proven technology but the high "up-front" costs are a major barrier. Small scale hydro can only be assessed properly in relation to other options if "life-cycle" costing is adopted as the basis for comparison. Feasibility studies, carried out on at least two remote sites, have shown micro hydro to be economically attractive when compared to diesel. The high initial cost of the micro hydro is the major obstacle.

- The applicability of biomass based systems (peat or wood) in the remote Ontario communities require that the necessary harvesting capability be developed and demonstrated.

- Turbine engines are considered too complex for operation in remote environments.

- Gasifier technology (eg. Ramsey demonstration project) is developing but it is not yet considered to be ready for application in most remote settings.

- Steam engines have a proven reliability record but then widespread use is constrained by two factors:

    - in most applications (greater than 50kW) continuous system monitoring by a 4th class stationary engineer is required.

    - the electrical conversion efficiency of steam engines is relatively low in comparison to other conversion technologies.

    - In order to achieve an attractive system efficiency, it is necessary to use the waste-heat for a space/water heating application.

- Steam turbine engines are relatively efficient and reliable. However, they use high pressure steam and are generally considered to be too sophisticated for most remote community applications.

- Wood harvesting techniques are fully developed, but to date there has been no demonstration at the required scale for community power, in a remote Native setting.

- Peat harvesting technology is commercially available, and is widely used in Europe, often at a much larger scale than is required for Ontario's remote communities.

3.0 IDENTIFICATION OF THE STRATEGIC ELEMENTS

3.1 APPROACH

The challenge facing the Study Team was to develop a framework within which the data summarized in Chapter 2 could be analyzed and the wide range of alternatives assessed and compared. The framework had to provide the basis for developing a limited number of elements of the strategy which would be practical and implementable and which together would make up a coherant strategy.

It was concluded by the Study Team that each element of the strategy should consist of:

- an identified end-use of energy
- an identified end-user or group of end-users
- identified technical option(s)

The Study Team began with an analysis of the major end-uses of energy. The next step involved identifying the specific end-users or groups of end-users which account for a large part of the energy consumed within an end-use category. A range of possible combinations of end-uses and end-users were then assessed using two main sets of criteria.

Firstly, the Study Team assessed their potential for contribution to the achievement of the objectives of the strategy. For the convenience of the reader these are repeated here. They are:

- to reduce dependence on fossil fuels in the remote communities;
- to maximize the potential for energy conservation (both wood and fossil fuels);

- to maximize the job creation and organizational development potential arising from the need to supply and/or conserve energy; and,

- to use the supply and conservation opportunities to enhance the range of services available, living conditions and life-styles in the communities.

Secondly, the Study Team took into consideration the following:

- the relevant priorities of the communities;

- Federal Government mandates and responsiblities;

- the potential for program delivery through or in conjunction with existing mechanisms;

- the existence and adequacy of existing Federal or Provincial programs directed towards the identified opportunities for strategic action; and,

- the existence of established research, development and demonstration projects which could have a bearing.

The selected combinations of end-use and end-user were then combined with the appropriate technical options to form elements of the strategy. The identification of technical options is dealt with in Chapter 4. The following is a brief description of the analysis which resulted in the selection of specific combination of end-uses and end-users as the focus for elements of the strategy.

3.2 TWO MAJOR END-USE CATEGORIES

As indicated in Section 2.4, space heating and diesel generation of electricity together account for 84% of total current energy consumption. Further:

- These two end-uses are projected to continue to account for the bulk of energy demand in remote communities;
- A significant number of the study communities are without electricity service and are actively pursuing options to obtain it. Consequently, if alternatives to diesel electricity generation are not introduced, fossil fuel requirements could double in the next decade;
- There exists a wide range of previously identified technical options for achieving increased efficiencies in the delivery of space heating and electricity services; and,
- Transportation, cooking, lighting and the operation of small motors account for a relatively small portion of total use (particularly if the transportation fuel consumption for the timber cutting operations in Armstrong and Ramsey are excluded), and the options for either increased efficiency or reduced use in these end uses are limited.

Therefore, the proposed strategy focussed exclusively on two end-uses:

- Electricity generation
- Space heating

3.3 ELECTRICITY GENERATION

The generation of electricity in Ontario remote communities falls into two categories. These are:

- Electricity Generation - Private/Institutional
- Electricity Generation - Community Power

The distinction between these two categories is made on the basis of owner and operator, but most importantly, user. One common feature is that almost all of the installations are conventional diesel sets.

3.3.1 Private Electricity Generation

3.3.1.1 Discussion

Private electricity generation relies on diesel (except for some small gasoline engines) and is found principally where community power is not available. Typically, institutions and non-Native commercial businesses own, operate and maintain their own diesel sets for provision of electricity to (only) their own facilities. The major owners/operators of private diesel generators are:

A. Native Communities
  - DIAND
  - MTC/Bell Canada
  - Hudson's Bay Company

B. Rail Communites
  - CN Railway
  - Other Commercial

It is anticipated that private generation of electricity for institutional or commercial use will decline in relative importance over the next decade as more communities obtain community power services. The Study Team therefore concluded that the substitution of electricity generation based on renewable resources for existing private installations would be practical only in a very limited number of cases, and thus was excluded from further consideration in the strategy.

The technical options for improved efficiency of diesel operations involve primarily heat recovery for space heating in adjacent buildings owned by the diesel owner/operator. Heat recovery is one of several options which can be considered for reducing fuel oil consumption for space heating these buildings. Therefore, consideration of these options is contained within the element of the strategy directed to space heating. In any case, as is noted above, with the expected advent of community power in many communities, the potential for cost-effective renovation may be limited.

The Ministry of Transportation and Communications owned and Bell Canda operated diesel sets are an exception to the above. These facilities (14 sites) are operated specifically to provide power to local communication equipment and are relatively small in terms of power output. Several technical options for reduction of fossil fuel consumption are presented in section 2.6.1. This area is therefore seen to be an important one, with numerous potential applications for similar sites.

3.3.1.2 Recommendations Regarding Private Electricity Generation

The Ontario Ministry of Energy has recently commissioned a detailed study to investigate alternatives for both Ministry of Transportation and Communications airport and telecommunications facilities. Further action beyond monitoring the implementation and information transfer is unnecessary at this time. Consequently, this area is not included as an element of the strategy but federal monitoring of developments is recommended.

3.3.2 Community Power

3.3.2.1 Discussion

This involves the provision of electricity service to residences, institutions and commercial facilities within the remote communities. This aspect of energy service in Ontario's remote communities is important because access to electricity service is a major social and political priority among most remote communities. As of September 1982 (Data Base Study), 19 communities had no service (46%) and a further 3 communities had partial or inadequate service (7%). With the exception of Sultan (micro hydro), all community electricity provided in Ontario remote communities is diesel generated and results in large operating losses. In comparison with demand for space heating energy, which is not expected to increase dramatically in the forseeable future, the demand for service in 22 communities not adequately serviced, could result in a doubling of current fuel oil consumption for electricity generation within the next decade.

At present the agency charged with producing community power is, with a few exceptions, Ontario Hydro. However, DIAND is now discussing with several Native communities that are ineligible for community power from Ontario Hydro, the possibility of funding community operated systems.

Two general categories of technical options have been identified. These are:

- Increased system efficiency through the recovery and use of diesel waste heat for space heating; and,

- Alternative electricity generating technologies.

Each is discussed below.

Waste Heat Recovery: The potential for increasing the efficiency of community power diesels through waste heat recovery is significant in part because diesels will continue to provide power in many communities for the next decade or more (in contrast to many private diesel installations). Over 5.2 million litres of fuel oil per year are used in all communities in the study area for space and water heating. Nearly half the total space heat requirement could theoretically be displaced if the waste heat from existing community power systems could be utilized. Assuming a waste heat recovery of 30% and a furnace efficiency of 60%, the waste heat produced by existing community power systems is equivalent to over 2 million litres of fuel oil for space heating. Allowing for the fact that waste heat can only be used during 6-8 months of the year, the real theoretical potential is therefore reduced to about 1 million litres equivalent per year. Even allowing for situations where it is impractical to use the waste heat in summer or where the heat produced is greater than the winter heating load in adjacent buildings, there is still potentially a large energy saving.

Alternative Electricity Generating Technology: Approximately 4 million litres of fossil fuel per year are currently used to supply electricity from existing community power systems in the study area. The addition of new community power systems would increase this consumption unless alternative energy sources can be used. Wood fired power systems and micro-hydro power systems have the potential for supplying 100% of the electricity required where applicable. Wind/diesel hybrid power systems have the potential to reduce fossil fuel consumption by 20 - 25%, where it can apply.

Although there are constraints associated with each of the alternative electricity generation options (see section 2.6), the significant potential long-run savings warrant continuation of developmental and demonstration initiatives.

The provision of community power is the most complex of all the areas of energy demand in Ontario's remote communities:

- it involves multiple agencies/departments within both federal and provincial levels of government;

- from a technical perspective, it involves a wide range of options with each option presenting its own set of trade-offs with respect to cost, reliability and ability to contribute to local employment, social and resource concerns. Yet, in most cases, no one option emerges as a clear choice; and finally,
- the provision of community power is particularly influenced by important but unsolved, political considerations; i.e. federal/provincial cost sharing, Native self-government, etc.

Demonstration projects using local renewable resources could be carried out within the exisiting framework through ad hoc arrangements. However, if renewables based options are successfully demonstrated, then a new, simpler and more coherent institutional framework may eventually be necessary to facilitate their widespread application.

3.3.2.2 Recommendations Regarding Community Power

It is recommended that the strategy address:

- heat recovery from existing and planned electricity generating installations;

- continued developmental and demonstration initiatives in the use of renewables for electricity generation; and,

- consideration in the medium to long-term of the need for new institutional arrangements for the delivery of community power, if the biomass based demonstration projects are successful.

3.4 SPACE HEATING

Space heating in Native and rail remote communities accounts for approximately 60% of current total energy consumption. Space heating accounts for 68% of total energy consumption in Native communities and approximately 40% in rail communities.

Three (3) sectors within remote communities account for space heating energy consumption. In order of energy consumed, they are:

- Residential (71%)
- Institutional (20%)
- Commercial (9%)

3.4.1 Space Heating - Institutional Sector

3.4.1.1 Discussion

The institutional sector accounts for only 20% of total space heating demand in Ontario remote communities. However, this sector is particularly important as it relies exclusively on fuel oil for space heating.

This sector consists primarily of government facilities located in remote communities for the provision of specific services. Employee residences provided by the institution are considered part of this sector rather than the residential sector.

Exhibit 3.1 provides further breakdown of the institutional sector in Ontario remote communities. Discussion and recommendations regarding institutional space heating in rail communities is presented in Section 3.4.4. With the exception of airport and communications and commercial facilities, the points dealt with below relate exclusively to Native communities.

EXHIBIT 3.1

REMOTE INSTITUTIONAL SECTOR - ONTARIO

Facilities	# of Study Communities	Annual Fuel Oil Consumption	% of Sector	Responsibility
1. Native Schools and Teacherages	26	2.1 million	76%	DIAND
2. Nursing Stations	7	300,000	11%	Health and Welfare
3. Airport and Communication Facilities	15	300,000	11%	Ministry of Transportation and Communication
4. Rail Schools and Teacherages	8	65,000	2%	Ministry of Education
TOTALS		2.765 million	100%	

Schools and Teacherages - Native Communities

Schools and teacherages in Native communities dominate energy consumption in this sector. In both relative and absolute terms the quantities and costs of fuel involved indicate these facilities merit primary consideration. Further, these facilities are a direct federal responsiblity. The technical options identified in section 2.6 show potential for significant energy and cost savings. In addition, they also can contribute significantly to local employment and skills development. Interviews with local federal officials revealed that they appreciate the potential for cost savings and are constrained largely due to a shortage of capital funds to carry out such measures under existing programs. Actions to upgrade these facilities are consistent with the implied aims of Native self-Government.

Nursing Stations - Native Communities

Nursing stations are also a direct federal responsibility and present opportunities for energy savings; however, the quantity of fuel involved is dramatically less than for schools. Interdepartmental liason to encourage Health and Welfare Canada to make use of the existing Federal Internal Retrofit Program is recommended, but there does not appear to be enough potential to warrant major attention in the strategy.

Airport and Communication Facilities

Airport and communication facilites are not a direct responsibility of the Federal Government. Section 2.6 of this report identifies several technical options with respect to both space heating and electricity generation suitable for these facilities. However, under a separate provincial study these options are currently being assessed and a detailed implementation plan is being developed for these facilities. Consequently, no further major federal role is required at this time, beyond monitoring of the Ontario Government efforts.

New Institutional and Commercial Buildings

Many of the remote communities are expanding and will require larger schools, nursing stations and stores. Even where the community is not growing some older structures will be replaced over time. There is also at least one community which will likely be moved during the next decade, and this will undoubtedly require new buildings. In view of the tremendous energy savings which are possible through energy efficient design (reductions in heating costs and fossil fuel use of up to 60%), it is essential that these new buildings be designed to the highest practical energy efficiency standard.

While some individual buildings have been designed with energy savings as a key criteria (e.g. the new school at Big Trout Lake), and while newer buildings in the communities are generally superior from an energy perspective, there has not been developed a generalized set of standards and guidelines specifically tailored to the northern environment.

For each individual project therefore, the choice of design is made without the benefit of such design standards.

3.4.1.2 Recommendations Regarding Institutional Space-Heating

In addition, the following recommendation relates potentially to both Native and rail communities:

- the strategy should address the potential for cost savings and reduction in fossil fuel dependency that can be achieved through new energy efficient building design.

The other recommendation emerging from the analysis of institutional space heating is specific to Native communities. It is recommended that:

- improving the space heating efficiency of DIAND operated schools and teacherages in Native communities should be an important element of the strategy.

A recommendation with implications for institutional space heating in rail communities is presented in Section 3.4.4.

3.4.2 Residential Space Heating

3.4.2.1 Discussion

Exhibit 3.2 provides a breakdown of the residential sector (dwellings occupied by local residents and Band offices) in Ontario remote communities. Of particular importance is the number and type of dwellings as well as current ownership/ responsibility arrangements.

Residential space heating in rail communities is addressed in section 3.4.4 as part of a broader program for rail communities (see page 40).

In the case of Native communities, it is recommended that the local Band offices be considered part of this sector for the following reasons:

- the type of construction is generally similar to that of the local housing;
- both the Band office and local housing are a Band responsiblity; and,
- although an important focus of community activity, the number of units (28) is considered too small to warrant a separate strategic element.

EXHIBIT 3.2

REMOTE RESIDENTIAL SECTOR - ONTARIO

Group	No. of Communities	No. of Units	% of Total	Housing Description	Ownership/ Responsibility
1. Native					
Residences	28	2,321	84.0	Poor quality No water/ Sewage 50-60% with electricity Wood-heated	Bands DIAND
Band Offices	28	28	1.0		Bands DIAND
2. Rail	13	413	15.0	Variable quality *50% centrally heated *75% with electricity	Private
TOTALS	41	2,763	100%		

* An approximation

Space heating in the Native residential sector is by far the largest single source of energy demand in Ontario remote communities. Native communities contain 85% of all remote residential units and 88% of the total population. Almost all of this space heat is supplied using wood, which means that measures to reduce energy consumption in this sector will not directly contribute to the achievement of the initial objective of this strategy.

However, there are a number of ways in which measures to improve space heating in Native residences could contribute to achievement of other objectives of the strategy. They are:

- improved energy efficiency in existing and new native housing provides opportunity not only to reduce energy consumption but also to address social and economic concerns in terms of improved quality of life and safety;
- indirectly, reduction in pressure on wood supplies for space heating may alleviate local concerns about the use of wood for biomass based electricity generation or substitution of wood for oil in space heating of institutional buildings and thus facilitate substitution of renewable resources for fossil fuels.
- the projected population growth in Native communities, combined with a pressing need to replace much of the older existing housing, means that new house construction will continue into the forseeable future; and,
- there is considerable potential for the transfer of skills to local people and some potential for incremental job creation.

In addition, there are strong institutional considerations which contribute to a rationale for a separate element of the strategy to deal with Native residences:

- the Federal Government pays virtually the full cost of all housing construction and major renovation through existing programs;
- only minor adjustments in the existing programs are required to achieve a great deal in terms of the objectives of the strategy; and,
- improved housing is one of the most important priorities of the remote Native communities.

3.4.2.2 Recommendations Regarding Residential Space Heating in Native Communities

It is recommended that space heating for residences in Native communities be addressed by an element of the strategy. Both renovation of the existing housing stock and new housing should be included.

3.4.3 Space Heating in the Commercial Sector

3.4.3.1 Discussion

The commercial sector accounts for 9% of space heating demand in Ontario remote communities. Generally, fuel oil is the predominant energy source in non-Native commercial facilities whereas wood is the predominant energy source in most Native commercial facilities.

Commercial Sector in Native Communities

In remote Native communities, the commercial sector includes both Native and non-Native businesses. Native businesses requiring space heating are almost exclusively small grocery/dry good stores and coffee shops, and are operated either as Band-owned co-ops or private businesses.

In general, Native commercial facilities are located in one of the following building types:

- old single room community schools which have been replaced by DIAND facilities. These facilities are often more than 20 years old.
- old Hudson Bay Company facilities. These also are typically quite old and relatively small in size (600-900 sq.ft.)
- locally constructed log buildings
- converted or modified residences

Precise data on the number of buildings and fuel consumption in these facilities are not available. However, it is estimated that they number less than 25. Further, a concurrent study under Phase I of the RCDP program concluded that beyond the substitution of more energy-efficient wood stoves, the poor condition of the Native commercial builings in six communities within the Windigo Area do not warrant a major investment in retrofit.

The major non-Native commercial operator in Native communities is the Hudson Bay Company which operates facilities in 14 communities. The Hudson Bay Company is eligible for existing federal and provincial programs and has both the financial and technical resources to implement energy efficiency measures.

Commercial Sector in Rail Communities

The commercial sector in rail communities is dominated by the major railway companies (CN, CP and ONR) and timber cutting operations (E.B. Eddy, Great Lakes Forest Products and Great West Timber). Primary space heating requirements are for company bunk houses or employee houses. All of these large energy consumers are sophisticated and capable of accessing existing federal and provincial programs. In addition, small independent local operators maintain dry goods stores (7 communities) and accomodation facilities (2 communities). In the smaller communities these facilities are generally similar to local residences. Total energy consumption among these operations is small.

3.4.3.2 Recommendations Regarding Space Heating in the Commercial Sector

It is not recommended that there be a strategy element addressing space heating in the commercial sector. Instead it is recommended that space heating in the commercial sector be addressed through strategy elements proposed elsewhere. Specifically:

- in Native communities the technology transfer achieved through residential and institutional space heating initiatives recommended above will assist local commercial operators in assessing their needs and the potential for reducing energy costs;

- an effort should be made to ensure that the Hudson Bay Company and other commercial operators in the Native and rail communities are aware of existing Federal programs and of the general kind of savings that might be available to them (there is further elaboration regarding information transfer for rail communities in Section 3.4.4).

3.4.4 Space Heating in Rail Communities

3.4.4.1 Discussion

Exhibits 3.1 and 3.2 above show that:

- Schools and teacherages in rail communities account for only 2% of fuel oil used for institutional space heating (65,000 litres);
- residential space heating in rail communities accounts for 14.7% of energy used for residential space heating.

In section 3.4.3 it has been noted that space heating in commercial operations in rail communities is dominated by the facilities of large, relatively sophisticated companies to which the existing Federal energy conservation programs are applicable.

These points led the Study Team to conclude that no one of these sectors (institutional, residential or commercial) should, on its own, be the subject of an element of the strategy.

The following considerations reinforced this conclusion:

- Regarding residential space heating the Federal Government does not have the broad mandate and delivery system capacity within the rail communities that it does within the Native communities;

- Although about 50% of the housing is technically comparable to that of Native communities, given the jurisdictional difference, direct intervention in the housing market in rail communities would require establishment of a separate delivery mechanism;

- Approximately 50% of the rail community housing stock is located in communities where housing conditions, access, level of technical skills and financial resources are judged to be adequate for householder use of existing federal and provincial conservation programs; and,

- Schools and teacherages in rail communities are operated by the Provincial Government (in contrast to those in Native communities) and therefore the Federal mandate regarding the facilities is indirect rather than direct.

However, the Study Team did conclude, based on interviews with officials and consultants and a review of the data base, that there is an across the board need in the rail communities for information and technology transfer. This would provide information regarding energy conservation technology and existing programs of assistance in conservation relating to all sectors (residential, commercial and institutional). An initiative involving information and technology transfer could contribute to a number of objectives of the strategy, through reduction in fossil fuel use, skills development and improvements to living standards.

Thus while the scope for Federal action is seen as more limited in the rail communities, there can still be an important role. The relatively high profile of the Provincial Government in these communities (particularly in terms of operating institutions) suggests strongly that any Federal initiative should be undertaken in cooperation with Ontario.

3.4.4.2 Recommendations Regarding Space Heating in Rail Communites

In view of the above discussion it is recommended that the Federal Government discuss with the Province the prospects of mounting an initiative of information and technology transfer which would address space heating in the commercial, residential and institutional sectors in rail communities.

3.5 PROPOSED FOCUS FOR ELEMENTS OF THE STRATEGY

The recommendations which form the basis for identifying specific elements of the strategy are summarized as follows. The strategy should address:

- heat recovery from existing and planned electricity generation installations;
- continued developmental and demonstration initiatives in the use of renewables for electricity generation;
- improving the space heating efficiency of DIAND operated schools and teacherages in Native communities;
- the potential for cost savings and reduction in fossil fuel dependency that can be achieved through designs and design standards for energy efficiency in new institutional and commercial buildings;
- the potential for improved energy efficiency and quality of life through the renovation of exising house stock and the development of improved new housing; and,
- an information and technology transfer initiative for rail communities.

Exhibit 3.3 summarizes the areas of focus for elements of the strategy which result from these recommendations. These elements are not listed in order of priority. Chapter 4 provides a detailed description of each element of the strategy and identifies applicable technical options, specific activities and the proposed allocation of implementation responsibility.

The Study Team believes that a strategy consisting of elements addressing the end-use/end-user combinations shown in Exhibit 3.3 would:

- have a balance between actions, which would yield substantial results in the near-term (elements C,D,E,F) and actions which have longer lead times but significant long-term potential (elements A and B);

- address end-use/end-user combinations which account for at least 60% and potentially over 80% of all fuel oil used in Native communities;

- have a balance between the various objectives of the strategy;

- make considerable use of existing Federal programs and build on the work being done under the Remote Community Demonstration Program; and,

- focus on areas where the Federal mandate and scope for action is particularly strong.

EXHIBIT 3.3

PROPOSED FOCUS FOR ELEMENTS OF THE STRATEGY

			Rationale for Inclusion in Strategy	
Title	End-Use	End-User	Contribution to Objectives	Other Considerations
A. Community Power-Heat Recover	Electricity	Communities, Ontario Hydro	.more efficient use of fossil fuels. .cost savings to government and the communities in the short to medium term.	.strong Federal mandate in Native communities in terms of potential users of waste heat. .existing planning process for Native community can be be adapted. .a single agency, Ontario Hydro, controls generating facilities.
B. Community Power - Development and Demonstration of Use of Renewables	Electricity	Communities, Ontario Hydro	.largest area of long-term potential for reduced dependence on fossil fuels. .employment creation. .technology transfer. .community development.	.electricity supply is a priority for the communities. .strong Federal mandate for Native communities. .several demonstration projects or related studies now underway across Canada.
C. Space Heating - Existing Schools and Teacherages in Native Communities	Space Heating	DIAND	.reduced dependence on fossil fuels. .cost-savings. .potential employment creation. .potential community development. .improvements in comfort for children and teachers. .potential for technology transfer.	.strong Federal mandate. .Existing Federal programs can be adapted. .communities would accord some of the proposed measures a priority.

EXHIBIT 3.3 CONT'D

			Rationale for Inclusion in Strategy	
Title	End-Use	End-User	Contribution to Objectives	Other Considerations
D. Space Heating - New Institutional Building Design	Space Heating	Various	.reduced dependence on fossil fuels. .reduced costs. .improved comfort for users. .potential for technology transfer.	.applicability for Federal and Provincial Governments across the country. .builds on initiatives of the RCIP.
E. Space Heating - Residential in Native Communities	Space Heating	Bands, Individuals	.reduced pressure on wood supplies. .improved living standards. .technology transfer. .employment and skills development.	.high community priority. .existing Federal programs can be adapted. .applicability across Canada.
F. Space Heating Information and Technology Transfer for Rail Communities	Space Heating	Institutions, Companies, Individuals in the rail communities	.reduced dependence on fossil fuels. .improved living standards. .technology transfer. .potential employment and community development.	.improved utilization of existing Federal and Provincial programs.

4.0 DESCRIPTION OF ELEMENTS OF THE STRATEGY

This chapter provides a description of each of the elements of the strategy. The description of each element is organized under the following main headings:

Summary

A brief summary of what is proposed.

Barriers to Implementation

Difficulties or impediments to be overcome.

Proposed Approach

The initiatives proposed to overcoming the barriers and successful implementation.

Applicable Communities

Where the initiatives are potentially applicable.

Role of the Federal Government

Which Departments could most effectively carry out various roles.

Anticipated Benefits

What could potentially be achieved in terms of the objectives of the strategy.

Costs

A preliminary estimate of incremental costs of recommended initiatives.

Action plans for each element of the strategy are proposed in Chapter 5.

The proposed elements of the Strategy are:

A. Heat Recovery from Community Power Installations

B. Community Power - Development and Demonstration of Use of Renewables

C. Space Heating Existing Schools and Teacherages, Native Communities

D. Space Heating, New Industrial and Commercial Building Design

E. Residential Space Heating in Native Communities

F. Space Heating in Rail Communities

4.1 STRATEGY ELEMENT A - HEAT RECOVERY FROM COMMUNITY POWER INSTALLATIONS

4.1.1 Summary

This element of the strategy is based on the assumption that for the forseeable future most community power installations (existing or new) will continue to be diesel sets. These diesels convert energy stored in fuel oil into electrical energy but in the process generate a great deal of heat which is at present almost always wasted. The energy efficiency and cost effectiveness of these sets could be improved very substantially if the wast heat could be used for space heating of buildings or for the provision of services to the community (e.g. laundromat). The key problem is that buildings which could use the waste heat are rarely located close enough to the diesels to make the proposition feasible. It is proposed that this problem be tackled through augmentation of the existing planning processes. The specific technical options included are:

- New Diesel with Heat Recovery

  Installation of new diesel community power systems with heat recovery. Where possible, systems should be located adjacent to existing buildings where waste heat can be used for space heating.

- Existing Diesel with Added Heat Recovery

  Siting of appropriate new buildings/facilities adjacent to existing diesel community power systems to enable future addition of waste heat recovery system for space heating in new facilities. In some cases, it may also be feasible to capture waste heat for use in existing buildings if they are sufficiently close to existing diesel sets.

STRATEGY ELEMENT A CONT'D

4.1.2 Barriers to Implementation

With regard to heat recovery the major technical barrier is the need for proximity. The user of waste heat generally must be located within 100 metres of the source. This is a barrier with respect to existing diesel sets/potential users which were often located at some distance from each other because of a desire on the part of Ontario Hydro to have the diesels near the air strip for ease of supplying fuel. Concerns about noise and emissions sometimes constituted a secondary problem. In most cases the potential for heat recovery simply was not considered. The Study Team believes that potential noise and emissions problems can easily be addressed technically. It also appears that the problem of distance from air strips is no longer as serious as it once was because of improved roads and transportation capabilities in the communities. In addition, the potential revenues from selling waste heat could be attractive enough to Ontario Hydro to compensate for added fuel delivery costs and problems.

4.1.3 Proposed Approach

The approach outlined over the next few pages relates to Native communities where the Federal mandate is particularly strong. A variant on the approach is proposed at the end of this section for rail communities.

Planning

With regard to heat recovery from community power diesel sets, there are three points at which planning can make sense:

1. at the time when a diesel set is being installed, replaced or upgraded;

STRATEGY ELEMENT A CONT'D

2. at the time when a new potential end-use is developed in a community (school, workshop, laundromat, etc); and,

3. as part of an overall community planning process.

The planning process, and the potential for intervention to ensure that any heat recovery potential is fully considered, is different for each of these cases. Given the number of actors involved in each kind of decision, it is the view of the Study Team that the communities themselves rather than any one of the institutions involved provide the best opportunity for ensuring that planning takes place. The Team therefore proposes that the Federal Government establish a capability (possibly an engineer) to assist the communities to engage in the required planning. In terms of the Native communities, it is understood that Tribal Councils have now or are retaining engineers who will assist them with their capital and facilities planning. The Federal Government could in turn provide technical advice to these engineers or directly to Band Councils. This could entail direct involvement in the facilities planning process in some cases or in other cases simple advisory services. In other cases where either Capital Planning or Comprehensive Community Planning processes are underway it could involve input into the planning process.

Diesel Installation

The installation of a new diesel generally results from a fairly complex process involving the Band Council, DIAND and Ontario Hydro. The Band must request the installation and the location of the diesel is subject to negotiation between Ontario Hydro and the Band. DIAND must consider the request in terms of its criteria for community power installation and in terms of its own funding priorities and seek program and Treasury Board approval. If Ontario Hydro criteria for installing community power are also met then DIAND and Ontario Hydro negotiate an agreement regarding

STRATEGY ELEMENT A CONT'D

the installation. Generally DIAND agrees to provide capital financing for the project and Ontario Hydro agrees to operate the system.

At present DIAND is considering funding several community power operations which do not meet Ontario Hydro criteria, and in these cases the project will be simply a construction project like any other carried out by DIAND. The intention would be for DIAND to build the systems and eventually turn it over to the Band to operate. None of these installations have taken place and details on how the operations would be handled or financed have not been finalized.

Regardless of whether DIAND is proceeding on its own or with Ontario Hydro, it would appear that when new diesels are installed there is an opportunity to plan their configuration and location to recover waste heat or to at least keep open the potential for the future. Opportunities may also arise if diesel sets are to be upgraded significantly or replaced -- the incremental costs associated with site relocation and heat recovery may be relatively low at these points.

The individuals responsible for these installations appear to be sensitive to the potential for savings through heat recovery. Hydro has, for example, planned to install the required additional equipment in their new installations. It would appear that what is required is he establishment of a planning process whereby:

. DIAND and the Band Council explore all potential end-uses;

. DIAND, the Band Council and Ontario Hydro plan the location of the diesel set to maximize the short-run or long-run potential for heat recovery; and,

STRATEGY ELEMENT A CONT'D

- the options for financing any incremental costs incurred and/or sharing the financial benefits are fully explored.

This latter problem is likely to emerge in almost every heat recovery situation. It is tempting to recommend that a mechanism be established to handle this funding issue (a special fund or a program). However, the Study Team is reluctant to do so until a few ad hoc arrangements have been tried and the full dimensions of the problem have been identified. It would not be cost-effective to establish a program to deal with an issue which in practical terms, may generate real problems in only a few cases.

The same principles would apply if Ontario Hydro were not involved; the planning process would only involve the Band and DIAND.

Facilities Planning:

When DIAND or the Band are considering the construction of new facilities they should:

- locate the facilities near existing diesel sets if possible;
- work with Ontario Hydro to consider any necessary modification of existing diesel sets;
- work with Ontario Hydro to develop a heat purchase agreement;
- where no diesel set exists, plan the location of the building where the installation of a diesel is possible and work with Hydro to ensure that when the diesel set is installed the heat recovery potential is realized.

STRATEGY ELEMENT A CONT'D

Community Planning:

A long-term process has been established whereby comprehensive community plans and capital plans are to be developed for all Native communities. Capital plans deal with physical lay-out and infrastructure plans only whereas comprehensive community plans consider economic development potential and social goals and objectives as well. Only a few of the remote Native communities have had comprehensive plans developed although many have had some community planning work completed and about eight have completed capital plans. It is proposed that the potential for heat recovery from community power from diesel generators be established as one of the important considerations in developing both capital plans and comprehensive community plans. With regard to capital plans this could entail designing commercial/industrial areas around existing diesel sets, or planning such zones and leaving space for the eventual installation of diesel sets.

With regard to comprehensive community plans there could be scope for broad ranging discussion of the longer-term potential for using renewable resources for the generation of electricity.

Data Assembly For Planning:

In order to support the planning process and provide necessary information on potential opportunities, it is proposed that an inventory of planned potential end-users and planned diesel installations be developed.

Rail Communities

The formal planning processes described above for Native communities do not exist for the rail communities, nor does the direct Federal role in the decision-making processes generally. It is proposed that the data assembly/inventory referred to above

STRATEGY ELEMENT A CONT'D

should address rail as well as Native communities. It is further proposed that the Federal and Provincial Governments, Ontario Hydro and local community representatives develop an arrangement whereby any specific plans that could yield and opportunity for heat recovery are brought to the attention of the energy producers and the potential users.

4.1.4 Applicable Communities

This strategy element is potentially applicable over the long-term in most communities using diesels. If biomass based generation systems are introduced, the potential for heat recovery would continue to exist. The proposed planning process would have to expand to address supply as well as demand related issues. Even wind diesel hybrid systems may have some potential. Only the micro-hydro option eliminates the potential for heat recovery

4.1.5 Role of the Federal Government

Native Communities

DIAND is involved directly or indirectly in all aspects of planning for the Native communities. It is proposed that DIAND develop expertise in heat recovery (in-house or through the use of consultants on retainer) which would be a resource for Bands and the engineers being hired by Tribal Councils. It is further proposed that a fund be administered by DIAND in support of meetings and travel required to disseminate information about the potential for heat recovery to the communities.

It is recommended that EMR through RCDP play a catalytic role, possibly through cost-sharing the DIAND activities on an experimental basis (possibly over three years on a declining

STRATEGY ELEMENT A CONT'D

percentage), and/or through assisting DIAND in developing detailed task specifications, and/or in the selection process for personnel (or consultants). EMR could also cost-share the development of the inventory system for potential sites for heat recovery as part of the demonstration effort.

Rail Communities

With respect to rail communities it is proposed that EMR consider sharing any costs associated with data assembly (the inventory of potential sites) and work with the Ontario Government and Ontario Hydro on an on-going basis to ensure that as opportunities arise the potential for waste heat recovery is given full consideration.

4.1.6 Anticipated Benefits

The benefits are primarily a reduction in the use of fossil fuels for space heating. The theoretical maximum savings noted above (page 29) is 1.5 million litres equivalent per year for existing diesel sets. This could mean significant potential financial savings for the operators of buildings.

4.1.7 Costs

Financing the proposal planning support role could cost in total approximately $100,000 to $150,000 over three fiscal years.

4.2 STRATEGY ELEMENT B - COMMUNITY POWER - DEVELOPMENT AND DEMONSTRATION OF USE OF RENEWABLES

4.2.1 Summary

Fuel for community power already represents the largest use of fossil fuels in the remote communities. Increased demand for community power will raise fossil fuel use even higher. The development and use of community power systems which utilize local renewable resources would reduce fossil fuel used in community power systems. The use of renewables also offers potential for local employment creation and community development.

However, each of the identified technical options is confronted by a number of constraints. The issues surrounding the production and distribution of electricity in the remote community context are complex and difficult. The Study Team proposes an approach to addressing the problems and issues that includes development work, demonstration projects and organizational planning. The technical options involved are:

. Micro-Hydro

The installation of small hydro sites using conventional and/or recently developed technologies.

. Wind-Diesel Hybrid

Installation of new wind/diesel hybrid system for community power or addition of wind turbine to existing diesel sets in coastal communities. It may also be possible to include waste heat recovery if site conditons permit.

STRATEGY ELEMENT B CONT'D

. Biomass

Continued development and demonstration regarding the most promising biomass based generating alternatives.

4.2.2 Barriers to Implementation

Cost

The initial cost of non-diesel systems is generally significantly higher in terms of capital expenditure, site assessment and systems design. This is particularly true for micro-hydro systems but it is also true for biomass based systems to some extent. Biomass based systems have another major drawback in that their long-term operating costs are considerably higher that diesel systems. Specifically, the conversion technologies that exist today require continuous monitoring by stationary engineers. The economics of a biomass system only compare well with those of a diesel system when both are assessed based on life-cycle costs and when the cost of the stationary engineers is shadow priced at zero or close to zero. In other words only when this skilled labour is considered to have little or no value, implying that the workers would otherwise be unemployed and receiving some form of social assistance, do the systems make sense economically. This may change if new technologies that require less monitoring develop.

Institutional

The current arrangements, whereby DIAND provides the initial capital and Ontario Hydro pays ongoing costs, encourages DIAND to choose the generation option with the cheapest initial captial costs. The community receives the electrical service, but pays only about 25% of the cost and has no role in the delivery. Neither the full-benefits nor the full costs of electricity

STRATEGY ELEMENT B CONT'D

generation currently accrue to any one of the parties currently involved and thus none have the necessary incentives to, for example, make trade-offs between using financial resources for the purchase of fuel oil or the purchase of labour.

Technical

With regard to micro-hydro, local concerns can arise with respect to right-of-way clearing and stream/river diversion. Micro-hydro is potentially limited to approximately 5 of the 9 communities where there is some potential.

With regard to wind/diesel, the Coniston demonstration project should answer most outstanding questions. A demonstration application is planned for 1985 in one of the 4 coastal communities which have a sufficient wind resource base for cost-effective generation.

With regard to biomass options, gasifier systems which offer longer-term hope for reduced operating costs require further developmental and demonstration effort.

4.2.3 Proposed Approach

It is the view of the Study Team that there is a considerable amount of work to be done in terms of policy development and technology development and demonstration before the full potential for using renewable resources to generate community power is known and widespread implementation contemplated. The requisite steps vary depending on the technical option.

Micro-Hydro

Micro-hydro technology is well established and in technical terms requires only site specific feasibility studies and adaptation

STRATEGY ELEMENT B CONT'D

for those sites where it is feasible. The main barrier is the substantial up-front cost and for Native communities the related problem of the split between capital funding (DIAND) and operating susbsidization (Ontario Hydro). The Study Team believes that prior to any further site specific feasibility work, the key actors involved in the decision-making process (DIAND and Ontario Hydro) should:

- agree to compare hydro costs with those of diesel sets on a life-cycle costing basis; and,
- reach an in-principle agreement regarding the point at which they would be prepared to accept higher initial costs in return for reduced long run costs.

Once this decision has been made, it is recommended that feasibility studies be considered for specific micro-hydro sites with high potential.

Wind-Diesel Hybrid

Wind-diesel technology has been successfully demonstrated at Coniston and will be ready for demonstration at a coastal Native site in 1985. If the remote Native installation is successful then the technology could be applied where the local wind regime renders it economic.

Biomass

Biomass options require two kinds of research and development work. Firstly, one constraint common to biomass options is the need for reliable harvesting of fuel. It is therefore proposed that the first step be the formation and operation of a Native wood harvesting demonstration in conjunction with the substitution of wood for fuel oil in space heating.

STRATEGY ELEMENT B CONT'D

This option would represent an appropriate pilot demonstration of wood harvesting techniques and local organizational development required for the larger scale effort required for a wood-fired community power system. It is an appropriate pilot project because:

- the volume required for space heating a school (estimated by Study Team at up to 150 cords/annum) represents a significant increase in the scale of wood harvesting currently carried out by any one individual/group (except Big Trout). Although considerably less than that required for most community power systems, the required local organization and reliability of supply are similar.

- the level of risk involved for the space heating option is relatively minimal. As previously presented, incremental costs for duel fuel systems versus oil systems are modest. In the event that the harvesting system fails, the heating system could simply revert to oil as before with a resulting minimal capital loss. If it works well, valuable experience would be gained for application to a wood-fired community power system and economic benefits would accrue to both user and the community/group providing wood.

The OME is currently carrying out a research study in this area. Within this study 3 communities will be identified which have adequate wood resources as well as organizational ability. One of these three communities should therefore be considered as a demonstration site for wood harvesting for wood-oil space heating of a school.

The second important element of Biomass systems is the conversion technology itself.

STRATEGY ELEMENT B CONT'D

- Gasifier technology has adequate levels of efficiency but is not yet technically reliable enough for application in most remote communities.

- Further R & D, field trial and optimization are required. The current OME demonstration at Ramsey will provide valuable operating experience. This application should be carefully monitored; if successful, further demonstration, possibly in Armstrong or other rail communities where available logging residues, access and availability of technical skills permit.

It is foreseen that only in the medium to longer term will demonstration of gasifiers be viable in remote Native communities (ie. 5 - 10 years). At this time, Native communities which have demonstrated fuel wood harvesting capability (ie., as per #1 above) would be logical choices for demonstration.

One possible alternative demonstration program may be at Cat Lake where the feasibility of using peat resources is being studied, if the study recommendations are positive.

4.2.4 Applicable Communities

The range of applicable communities varies considerably depending on the technical option and the resource base of the community. Wood is generally available for all but a few communities although there may be local concern about the potential impact of large-scale harvesting of fuel-wood supplies for residential heating. The availability of peat resources is widespread, but the number of communities where the resource is reasonably proximate and accessible with existing technology is not clear. Wind is probably limited to 4 coastal communities. Micro-hydro is probably limited in practice to a maximum of 5 or 6 sites. A very preliminary assessment of resource availability is provided in Appendix D.

STRATEGY ELEMENT B CONT'D

4.2.5 Role of the Federal Government

The Federal Government can make an important contribution in several ways. Firstly, it can work with Ontario Hydro, Native communities and the Ontario Ministry of Energy to attempt to reach a concensus on life-cycle costing for micro-hydro and on an in principle decision on capital/operating funding trade-offs. DIAND would be the key Federal actor with support from EMR.

Secondly, through the RCDP, the Federal Government (EMR) can support several biomass demonstration projects across Canada involving a variety of technologies and using both peat and wood. Thirdly, it can monitor the evolution of technology in the biomass electricity generation field and try to ensure that this information is brought to bear in future decisions regarding community power.

4.2.6 Anticipated Benefits

Cost/Fossil Fuel Savings

It was noted above (page 28) that a significant portion of the 4 million litres of fossil fuel currently (1981) used for community power systems could be potentially displaced by using renewables if the appropriate technology evolves.

Employment

The use of biomass fuelled community power systems would provide on-going community employment in the form of harvesting, fuel preparation, and system operation jobs. All community power installations provide some temporary employment. Micro-hydro and wood systems would provide the largest number of temporary local jobs. Installation of heat recovery systems on existing community power systems could lead to permanent employment

STRATEGY ELEMENT B CONT'D

operating a community service such as a laundromat which used the waste heat.

Community Development

The use of micro-hydro, wood, and wind/diesel community power systems would also bring new technologies to the study area which could be used to develop new skills through community education and vocation programs.

Finally, the local production of electricity using local renewable resources (particularly biomass) presents potential opportunities for the community development, increased civic pride, and improved management and technical skills.

4.2.7 Costs

It is extremely difficult to assess the incremental costs associated with the above activities. Biomass demonstration projects will vary tremendously in cost depending on the fuel selected, the access to fuel sources, the technical option selected and the location of the community.

4.3 STRATEGY ELEMENT C - SPACE HEATING EXISTING SCHOOLS AND TEACHERAGES, NATIVE COMMUNITIES

4.3.1 Summary

This element addresses space heating and water heating, primarily in existing community schools and teacher residences in Native communities. Currently, these facilities are owned and operated by DIAND. Future responsiblity for ownership and operation of facilities may be transferred to the local Band Councils if the planned process towards implementing self-government is continued. The present description of this element assumes continued DIAND responsibility. Nonetheless, most aspects of the following are transferrable in the event that the Band Councils assume increased responsibility. It is assumed that regardless of responsibility, these same facilities will continue to operate. The key obstacles are initial cost and the lack of specialized technical knowledge among DIAND staff. It is proposed that EMR provide technical advice and support for DIAND in the budgetting process.

This strategic element combines three technical options:

- Retrofit of DIAND Buildings (schools and teacher residences) in Native communities;
- Substitution of wood for oil in space heating in DIAND (school) buildings in Native communities; and,
- Heat recovery from DIAND (school) operated diesel generating sets for space and/or water heating in adjacent DIAND (school) buildings in certain native communities.

The above options are combined into a single strategic element in recognition of their technical and planning linkages:

STRATEGY ELEMENT C CONT'D

- Each of these options address the same end-use application of petroleum; namely, space and/or water heating in school facilities;

- In each case, an optimum site-specific action plan will require consideration of the above options. For example in an existing school, retrofit of the building envelope will likely be desirable. However, the remaining (reduced) demand for space and/or water heating may be met by either heat recovery or wood substitution.

4.3.2 Barriers to Implementation

The major barriers to implementation are:

1. DIAND presently pays all fuel costs; however the total expenditure for energy purchase in remote communities is only in the range of 1.5% of DIAND's Ontario annual budget. Therefore fuel expenditures may not be a high priority.

2. District offices lack sufficient capital to implement identified retrofit measures. Any initiatives requiring up-front captial costs must be weighed against competing use of funds for that fiscal year. Given the pressing social/economic problems, energy initiatives are often not accorded high priority by regional offices when provincial DIAND budget allocations are determined.

3. A major potential source of DIAND funds for building energy retrofit is EMR's Federal Internal Retrofit Program; however, delayed project approval times, partial funding etc, have severely restricted the level of activity undertaken.

STRATEGY ELEMENT C CONT'D

4. DIAND technical staff, while generally knowledgable about energy efficiency techniques, do not have all of the necessary specialized skills.

4.3.3 Proposed Approach

Presently, it is DIAND which owns and operates all of the school facilties, except in communities which do not have official reserve status. It is the view of the Study Team that this Strategic element addresses several DIAND objectives in terms of delivering services at lowest overall cost, delivering improved services (greater comfort) and creating short- and long-term employment. The community would likely support a program if it were properly presented since they too are interested in employment creation and skills training. Further, Bands may eventually be faced (in the event of progress towards self-government) with having to pay fuel costs out of block funding.

The proposed approach involves five main thrusts:

- technical support to field staff who, based on interviews conducted by the Study Team, appear to be enthusiastic about the potential savings and other benefits associated with the technical options;
- EMR-DIAND cooperation in making full use of the existing EMR program for retrofit of Federal Government buildings;
- DIAND exploration of potential opportunities for heat recovery;
- demonstration project(s) for dual-fuel school heating systems; and,

STRATEGY ELEMENT C CONT'D

. advocacy by EMR with DIAND regarding the initial investments required and (if appropriate) support of DIAND through the budgetory process with Treasury Board.

4.3.4 Applicable Communities

The approach outlined above is potentially applicable in all Native communities, barring those for which relocation is imminent. It is possible, however, to sort or priorize on basis of: size, age and condition of facilities. Communities identified in studies now being carried out under the RCDP as having excellent potential for biomass based electricity generation could be accorded high priority for demonstrating dual-fuel school heating system.

4.3.5 Role of the Federal Government

The space heating needs addressed in this element of the strategy are the direct responsibility of DIAND, and it is this Department which must determine whether making the kind of investments contemplated is a high priority, given other pressures on its capital funds. EMR can only provide advice and support in this regard.

With respect to dual-fuel heating systems for schools, RCDP could be one possible source of funding for a demonstration project.

With respect to the provision of ongoing technical expertise to field staff, this again would have to be a DIAND responsibility.

STRATEGY ELEMENT C CONT'D

4.3.6 Anticipate Benefits

Cost/Energy Savings

Space and water heating account for approximately 40% of total petroleum (fuel oil) consumption in remote Native communities. Schools and teacher residences account for over 65% of this demand. These facilities, presently owned and operated by DIAND, are located in 28 remote Ontario communities. In 1981, the total area of these facilities was approximately 303,000 square feet (28,000 square meters).

Annual fuel consumption (1981) for space and water heating in these facilities is estimated to be approximately 2,100,000 litres. Current (1983-84) on-site fuel prices are, on average, about 65 cents/litre. Thus 1983-84 fuel costs for space and water heating in these facilities are estimated to be $1,400,000.

- Retrofit of these facilities, including increased insulation levels and reduction of air infiltration, can result in annual energy savings of 20-30%. The expected simple payback on this level of retrofit is between 1 and 3 years, based on retrofit experience in other locations.

- The gradual replacement of existing oil-fired school heating systems with dual fuel units (wood/oil) could reduce fuel oil consumption to 10-20% of current levels. At present fuel oil prices (65 cents/litre) and present local wood prices ($100-150/cord) school heating costs could be reduced by up to 50% (65 cents/litre is equal to $300/cord of wood assuming constant conversion efficiency).

STRATEGY ELEMENT C CONT'D

- A dual fuel system would also provide a back-up system in the event of the failure of one system. This would reduce the risks of possible additional costs resulting from freezing of school facilities.

The opportunities for waste heat recovery from DIAND operated diesel generator sets are constrained by 2 major factors: engines are air-cooled (therefore reducing by 50% the amount of capturable heat); and, DIAND diesels are being displaced by Ontario Hydro community power systems. Nonetheless in isolated case (i.e. school replacement or upgrading in a community without forthcoming community power) waste heat recovery from a properly sited and loaded liquied cooled diesel generator could displace all, or a significant portion, of the school's heating requirements.

Increased Comfort

In severely cold or windy weather a number of school facilities are too cold and drafty for comfortable use. This means that students must periodically attend classes wearing their outdoor clothing and/or be sent home. Consequently, valuable teaching time is lost. Proper retrofit would reduce or eliminate this lost time and/or student discomfort.

Employment and Skills Development

"Imported" fuel oil creates little local employment within remote communities. From the community's perspective, the purchase of "imported" fuel oil represents a significant outflow of captial and related employment development opportunities.

The supervised retrofit of existing school facilities not only provides local employment opportunity but also provides an excellent opportunity for demonstrating retrofit techniques in the community -- much of which will be applicable to other

STRATEGY ELEMENT C CONT'D

facilties -- and for developing and transferring retrofit skills to local residents for application in other community buildings.

It is estimated that about 40 to 60 cords of wood would be required for space heating of an "average" school using a dual fuel system. If other facilities, such as teacherages, were converted to dual fuel sytems this volume would be increased. In some sites, the volume could be as much as 150 cords/annum. The supplying of the required volume of fuel wood could result in 2-3 permanent part-time jobs in each community.

4.3.7 Costs

Incremental costs are site specific and should only be incurred when the pay-back period is attractive (up to 5 years is suggested). The costs of EMR supporting role are unlikely to be significant. For example, the incremental capital costs of a dual-fuel demonstration project would be unlikely to exceed $10,000.

4.4 STRATEGY ELEMENT D - SPACE HEATING, NEW INDUSTRIAL AND COMMERCIAL BUILDING DESIGN

4.4.1 Summary

Energy efficient institutional and commercial buildings could yield substantial long run savings and reduced dependence on fossil fuels.

While some energy efficient buildings have been designed and constructed in Ontario remote communities and while newer buildings in the community are generally more energy efficient, the Study Team believes there is a need for a generalized and accessible set of standards and guidelines. A second part of this strategy element involves the development of standardized modular designs for typical buildings required in the remote communities (e.g. schools).

While the proposed activity is for Ontario the technology would be applicable throughout Canada in remote and non-remote communities.

4.4.2 Barriers to Implementation

The staff of DIAND and NHW who were contacted were very interested in improving the energy efficiency of new buildings. While initial costs could be higher it is their view that the short pay-back periods on incremental costs are such that this should not present a major barrier.

The problem appears to be that while Federal technical staffs in the agencies concerned have a good general understanding of the technology, they have no coherent set of standards and guidelines to which they can refer. For each individual project therefore, the choice of design is made without the benefit of such a tool. Such guidelines as do exist are not sufficiently comprehensive or detailed to meet their needs.

STRATEGY ELEMENT D CONT'D

There are also no energy efficient standarized designs for the kind of commercial buildings that are regularly required in the remote communities.

4.4.3 Proposed Approach

The proposed approach involves the development of standards in terms of:

. basic structural techniques

. building configuration

. building siting

. the use of vapour barriers and sealing techniques

. insulation standards

These standards could be developed by EMR in consultation with the Department of Public Works, DIAND and Health and Welfare and the Ontario Ministry of Energy.

A second aspect of the strategic element would be information transfer -- ensuring that the standards developed and the potential benefits of adopting them are made available to the full range of potential users. These would include federal and provincial agencies, the Bands (with regard to stores, cafes, workshops, Band offices, etc.) and commercial groups (e.g. Hudson's Bay).

The third part of the approach would involve the development of standardized designs for modular buildings for the two or three most widespread kind of government and commercial building (e.g. schools, teacherages, nursing stations, stores).

STRATEGY ELEMENT D CONT'D

While these designs would have to be adapted to the specific sites and size requirements, a modular approach could maximize their usefulness. For example, some communities could require a five-room school house while others would only need a three classroom school house, but up to a point the common facilities required would be the same, and each classroom could be the same.

4.4.4 Applicable Communities

The solutions proposed could be applicable in any community where new construction is being proposed by any level of government or the private sector.

4.4.5 Role of the Federal Government

EMR could play a catalytic role, working with DIAND, Health and Welfare and the Ontario Government in:

- developing the standards and standardizing designs and bringing together the potential end-users;
- funding role in terms of development of the standards and the standardized design; and,
- support role in terms of assisting Federal agencies requiring any increased capial financing -- to make their case to central agencies.

4.4.6 Anticipated Benefits

The benefits, chiefly reduced fossil fuel consumption and costs (see page 34), would accrue initially to the governments involved. In the longer run, if self-government proceeds as

STRATEGY ELEMENT D CONT'D

anticipated, the Bands would benefit from design improvements if they assume operating responsiblity for the buildings.

4.4.7 Costs

Design work and preparations of guidelines and standards could cost several hundred thousand dollars.

4.5 STRATEGY ELEMENT E - RESIDENTIAL SPACE HEATING IN NATIVE COMMUNITIES

4.5.1 Summary

This strategic element addresses space heating in existing and new Native housing. The anticipated benefits of this strategic element include reduced wood consumption, improved home comfort and safety and short-term jobs. The major problems to be addressed in the strategy relate to technical skills and knowledge.

Band offices are included in this strategic element because they are susceptible to many of the same solutions as the housing and because they are owned by the Band and therefore could easily be included in many aspects of the proposed program. For example, the Band office could be used as a demonstration site for retrofit techniques.

The implementation plan calls for demonstration, technology transfer, the use of exisiting housing and employment programs, and incremental grant funding. The technical options are:

- Energy Retrofit of Existing Residences
- Construction of New Energy Efficient Residences
- Substitution of Efficient Wood Stoves

4.5.2 Barriers to Implementation

The major barriers are as follows.

Lack of Local Skills:
In many remote communities, local residents have recognized the need for improved energy-efficient housing. However, they lack

STRATEGY ELEMENT E CONT'D

access to training and experience in specific construction techniques such as:

- application of continuous air/moisture vapours;
- construction of energy-efficient "curtain" walls or strapped walls to obtain high insulation values;
- construction of stable foundations or footings to reduce building movement, etc;
- air management techniques i.e. combustion air vents for wood stoves, etc; and,
- proper building siting to maximize solar gain.

Northern Housing Infrastructure:
The majority of remote housing is purchased as a "package" from lumber supply companies in Winnipeg, Pickle Lake, Thunder Bay, Timmins, etc. Generally, the designs and materials provided are those of low-cost bungalows normally situated in non-remote settings and heated by central heating systems. These "home packages" are designed to meet minimum first cost criteria and therefore sacrifice most energy efficiency criteria including efficient wood stoves.

The northern housing infrastructure, dealing with a relatively captive audience, is therefore providing only marginal support to remote communities striving to improve the energy efficiency of their housing.

Cost:
Additional costs are incurred primarily for the initial house design and for the initial training in construction techniques. These, however, are first time costs that need not represent a recurring cost increment.

STRATEGY ELEMENT E CONT'D

4.5.3 Proposed Approach

Work With Existing Programs

At present, the total Native remote community housing stock is approximately 2300 units. In 1984, plans call for the construction of 274 new housing units and for major repairs to 191 houses (this includes 41 receiving wiring in anticipation of community power). Construction funds are subsidized by DIAND. The total DIAND funding for this construction activity is $11,989,200, including transportation and materials.

The current financing for new housing comes primarily from the DIAND capital budget and from an economic development subsidy. Some small amounts of money may be provided by Bands or individuals. The housing money goes to the Bands as part of thier total capital allocation, and they have a degree of discretion regarding the use of the funds. Theoretically Band could opt to build no housing in a given year, but in practice housing is a high priority. The maximum allowable amount of financial assistance per housing unit has increased substantially in 1983 because of the use of economic development fund money to supplement capital budget allowances. It is anticipated that this practice will continue. For the remote communities identified in this study, the maximum new housing contribution for this year is $29,307 from the DIAND capital budget plus $12,000 from the DIAND economic development fund. Transportation costs which can be as high as $23,000 are in addition to these amounts. This level of funding would provide an adequate basis for the construction of energy efficient homes. Incremental supplements may be required to cover initial design, labour training, and possibly some additional materials costs.

Site visits by Study Team members provided insight into the number of homes for which retrofit was considered to be both practical and of interest to local residents. While not all of

STRATEGY ELEMENT E CONT'D

the older housing stock is suitable for retrofit measures, there has been a marked improvement in the overall quality of recent housing. Some of these units incorporate 2" x 6" construction with improved levels of insulation and air/vapour barriers. More efficient wood stoves, including proper installation of prefabricated insulated chimneys, have also gained increased acceptance.

Most Bands limit expenditures for renovations to $11,000 ($6,250 from the Central Mortgage and Housing Corporation, the maximum available without a matching personal investment, plus $6,000 from DIAND). Energy retrofit measures could not be included within overall renovation costs.

The Study Team is convinced, based in part on the results of other studies funded under the RCDP program in Ontario, that new energy efficient housing can be constructed in remote Native communities within the financial limits of the existing DIAND housing program ($41,000 plus transportation of materials paid at cost). Similarly, renovations to existing homes including energy conservation measures can be completed, where appropriate, within the program limits of DIAND-CMHC funding ($12,250).

Work With the Native Leadership

Site visits to some remote communities by Study Team members confirmed that community residents:

- are very interested in constructing more comfortable, durable and energy-efficient housing;
- are interested in energy-efficient wood stoves; and,
- are somewhat interested in energy retrofit measures for existing housing.

STRATEGY ELEMENT E CONT'D

Native communites are increasingly assuming control over the housing program in their communities and would welcome any support which helped them to improve the quality of their housing.

There is an organization called the Ontario Indian Housing Council which advises on housing matters and has developed a Building Code for Native Housing. One possibility would be to fund this organization to carry out the activities specified in the action play (see Section 5.5).

Technology Transfer is the Main Thrust

The program framework exists and the interest in energy efficient housing is high. The techniques associated with new energy efficient construction are well developed and there is a growing body of practical experience in remote northern settings. The Ontario Government is currently undertaking a demonstration project in Armstrong Ontario involving the design and construction of energy efficient housing and the energy retrofit of a sample of existing residences. Consequently, this option has the advantage of requiring little or no new technology development. Rather, it requires the transfer of developed technology.

The proper installation and operation of efficient wood stoves is also fully developed and not particularly complex. Again, it is only technology transfer through user education and training that is required.

The specific activities proposed are:

- the development of new energy efficient designs, building on work done for the RCDP in Ontario and elsewhere and developed in consultation with Native leadership;
- dissemination of design and materials specifications for energy efficient housing to northern building suppliers;

STRATEGY ELEMENT E CONT'D

- the demonstration of new construction methods and retrofitting techniques within actual communities; and,
- training and supervision of local labour to facilitate the transfer of technology.

4.5.4 Applicable Communities

This element is applicable to all Native communities, except for any community where site relocation is imminent.

4.5.5 Role of the Federal Government

The broad approach proposed involves augmenting and complementing existing Federal Native housing programs. The transfer of technology through demonstrations and training would assist the Bands to use the existing Federal housing funds in more energy efficient ways. A catalytic role is proposed for EMR, possibly funding part of the initial design costs and demonstration projects. DIAND would have the longer-term responsibility.

4.5.6 Anticipated Benefits

Improved Quality of Life

Perhaps the most important benefit of this element is its potential to positively impact on the local quality of life. The long, cold winters mean that residents spend a great deal of time indoors. Many existing homes are cold, drafty and, particularly in very cold weather, wood stoves (only heat source) must be fired to unsafe levels, simply to keep interior temperatures at a habitable level.

STRATEGY ELEMENT E CONT'D

The poor thermal quality of these homes results in:

- very wide heat gradients within homes ie. overly hot near the stove yet excessively cold near floors or areas of the home furthest from the stove. This is particularly uncomfortable for older residents who may suffer from arthritis, rheumatism, etc.
- excessive "over-firing" of wood stoves exacerbates the already dangerous fire hazard presented by poor quality, difficult to control wood stoves.

Energy efficient construction techniques are well developed and result in superior comfort with respect to heat gradients, elimination of uncomfortable drafts, more comfortable humidity levels etc. Some relatively minor modifications to the design of new housing would result in significant functional improvements. For example, current housing designs:

- do not provide for safe storage of gasoline for skidoos, motorboats and chainsaws;
- do not have proper footings/foundations resulting in excessive structural movement;
- provide no sheltered working or storage areas; and,
- provide no area for wood storage; and,
- wood stoves are not conveniently situated within the house for efficient loading, ash removal or heat distribution.

As a result of the absence of many of these design features, the lifetime of many houses is shortened. For example the only place to fix a broken skidoo or skin a deer, at -40 degrees C, is often

STRATEGY ELEMENT E CONT'D

the living room floor.

Further, modern efficient wood stoves, if properly installed and operated, can be easily regulated, either manually or automatically, to provide a more comfortable and even heat. More importantly, the potential fire hazards associated with present practices are reduced.

While replacement of many of the older homes is probably more desirable than renovation/retrofit, a significant number of the more recent existing homes can benefit significantly by relatively modest retrofit actions, such as:

- caulking around doors, windows and baseboards;
- weather stripping doors and windows;
- replacement of inefficient/unsafe wood stoves and chimneys; and,
- upgrading ceiling insulation levels and air/vapour barriers.

There is no doubt that improved quality of housing is a major local concern. In fact, the disparity between the quality of housing provided to Non-Native Institutional employees (i.e. DIAND, H & W etc.) is a political "sore spot". Therefore, it is possible that retrofit of institutional facilities and residences (Strategy Element C) would generate local resentment in the absence of a strategic element which addresses the concerns of local residents.

Resource Conservation

Previous experience has shown that the energy demand for space heating in new housing can be reduced by up to 85%. The

STRATEGY ELEMENT E CONT'D

household demand for wood can be reduced from the present level of up to 10 - 12 cords to as little as 2 - 4 cords.

The installation of energy efficient wood stoves can result in an increase in the present efficiency of 20-30% to 60-70%. Thus wood consumption can be reduced by 30-50% in existing homes.

Other retrofit options for existing, newer housing can further reduce wood consumption by about 10 - 30% depending on the original condition of the house and the extent of the measures implemented. The cumulative resource impact of the above options is to drastically reduce the present demand on wood resources. This is particularly of benefit to those communities (coastal) where wood resources are scarce, or to communities contemplating substitution of wood for fuel oil in space heating or electricity generation options.

Employment Skills

Both retrofit and energy efficient construction of new homes provide valuable employment opportunities. The skills transfer required represent a valuable addition to local building skills.

4.5.7 Costs

Design work could cost $25,000. The costs of proposed demonstration projects are estimated at $8,000 to $12,000 per demonstration, to cover supervision and training costs.

4.6 STRATEGY ELEMENT F - SPACE HEATING IN RAIL COMMUNITIES

4.6.1 Summary

The Study Team has indicated in Chapter 3 that the scope for Federal Government action in rail comunities with respect to any **single** area (e.g. space heating of housing, space heating of public buildings, electricity generation) does not appear to warrant the development of a separate element of the strategy. It would also be very difficult for the Federal Government to address rail communities as part of Strategy Element C and E as the delivery mechanisms for these Strategy Elements are integrated with existing federal programs which are limited to Native communities.

There are, however, opportunities for energy conservation in space heating in the rail communities which, cumulatively, do warrant attention. For example, the fact that no new housing program comparable to that described in Strategy Element E, exists for the rail communities, reinforces the importance of at least some aspects of housing retrofit identified. Also there are a range of government and commercial buildings in the rail communities which could benefit from retrofit activities. This was recently demonstrated in Armstrong under the RCDP, where significant savings were identified for four buildings that were analyzed.

Thus, the Study Team concluded that a Strategy Element which addressed the full range of space heating conservation opportunities in the rail communities, and which focussed on technology transfer, could reduce fuel consumption and yield improvements to the comfort and safety of rail community residents.

The specific technologies which are potentially applicable in either the short or long run include:

STRATEGY ELEMENT F CONT'D

- retrofit of residential, institutional and commercial buildings;
- energy efficient new construction;
- energy efficient wood stoves;
- heat recovery from private or community power systems; and,
- wood-oil dual fuel space heating systems.

4.6.2 Barriers to Implementation

Initial cost is a particular problem. Many communities are relatively poor and lack the kind of extensive funding provided to Native communities through DIAND. There are, for example, no housing programs except those available to all Ontario residents.

Institutional arrangements constitute a major barrier in that: the communities lack the formal administrative structure of southern communities and many lack any depth in organizational skills; the housing sector is by and large in the hands of individual residents; the public sector end-users are in the hands of several provincial agencies; and, the corporate sector, especially CN, dominates some communities.

Uncertainty about the prospects for community longevity is also a serious factor inhibiting individuals, companies and government agencies from investing in projects with lengthy paybacks (more than one - two years).

The quality of existing housing in the communities is sometimes such that extensive retrofit efforts are not warranted (poor foundations, settling, poor construction quality are problems).

STRATEGY ELEMENT F CONT'D

Most community residents lack the necessary knowledge and skills to implement appropriate retrofit measures or use new construction techniques.

4.6.3 Proposed Approach

The proposed solution consists of:

- technology transfer - a broad effort to increase awareness among residents and businesses of the advantages of retrofit, and energy efficient construction; and,
- planning - a comprehensive energy plan should be prepared for each community (unless abandonment appears imminent), addressing housing, government and commercial buildings, and heat recovery possibilities.

4.6.4 Applicable Communities

Priority should be accorded to those communities with an assured future, but all communities could be subjected to the review process recently completed for the Windigo Tribal Council.

4.6.5 Role of the Federal Government

It is proposed that the Federal Government work with the Ontario Ministry of Energy on developing a technology transfer program. This could involve partial funding under RCDP of the development of communications packages and possibly the partial funding of a demonstration energy plan for a rail community.

STRATEGY ELEMENT F CONT'D

4.6.6 Anticipated Benefits

The benefits of these measures would include increased comfort and safety for residents and significantly reduced consumption of fuel oil, wood and propane.

While some of the exising homes do not warrant extensive renovations, most can benefit significantly from:

- caulking around doors, windows and baseboards;
- weather stripping doors and windows;
- replacement of inefficient/unsafe wood stoves and chimneys or, furnace maintenance in the case of oil furnaces in centrally heated homes; and,
- upgrading ceiling insulation levels and air/vapour barrier.

Through technology transfer and the proposed energy planning process efforts, commerical and institutional building operators can be made aware of significant potential savings from:

- retrofitting
- heat-recovery
- energy efficient new construction
- wood-oil dual fuel space heating systems

Some local employment could also result from the implementation of these measures.

STRATEGY ELEMENT F CONT'D

4.6.7 Costs

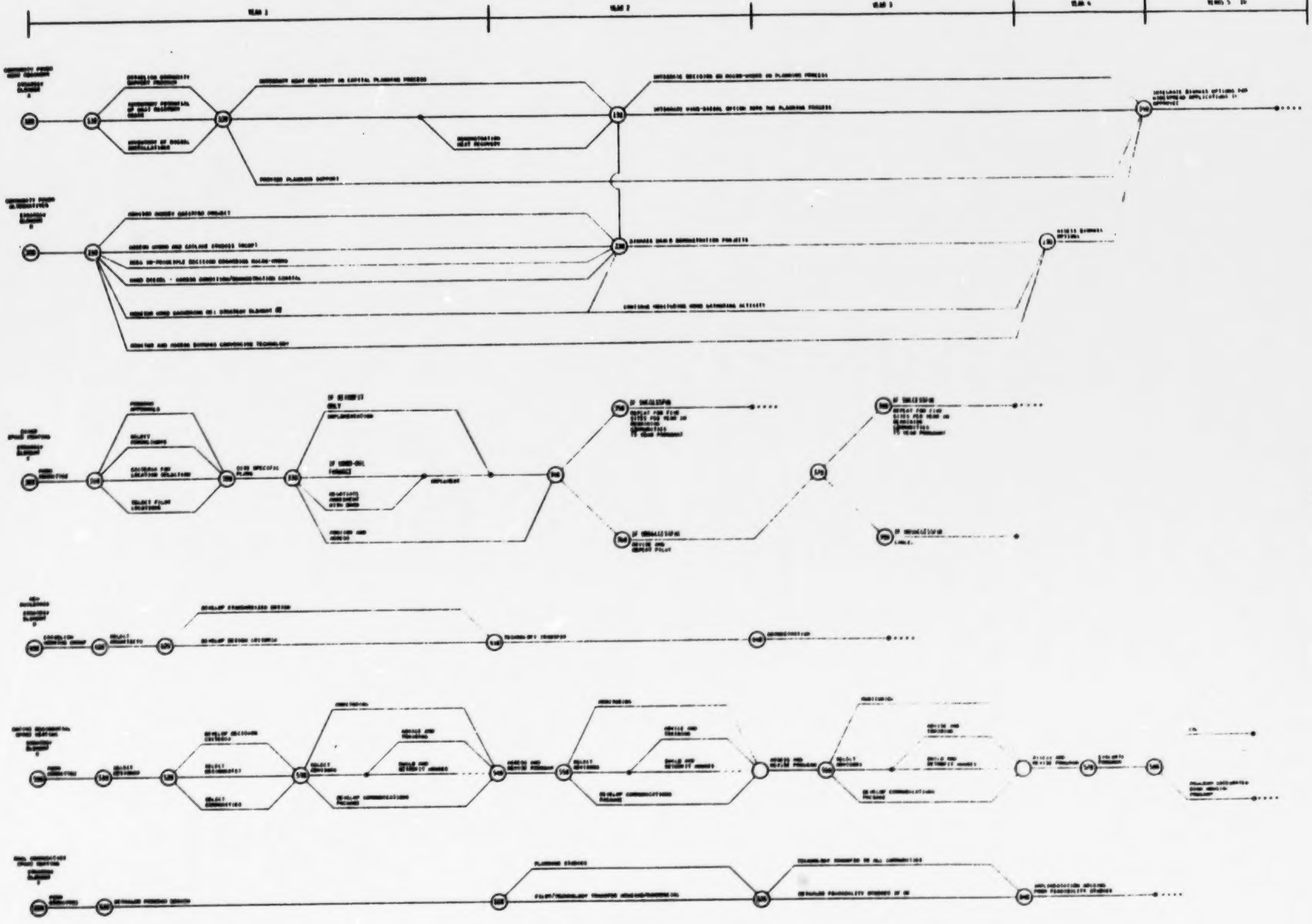
Funding of energy planning studies for the 13 communities would likely cost in excess of $100,000.

Funding of technology transfer/training program on pilot basis would cost approximately $7,000 to 10,000 per community.

5.0 IMPLEMENTATION PLAN

Exhibit 5.1 sets out the proposed action plan for each element of the strategy in a flow diagram, placing the activities in a time frame and an overall strategic context. The exhibit also shows some of the potential interrelationships. The following section provides an elaboration regarding the action plans for each element.

EXHIBIT 5.1: IMPLEMENTATION PLAN



YEAR 1
YEAR 2
YEAR 3
YEAR 4
YEARS 5 - 10

5.1 ACTION PLAN FOR STRATEGY ELEMENT A - ELECTRICITY GENERATION AND HEAT RECOVERY - COMMUNITY POWER

1-3 Years

120 . Seek in-principle decision regarding micro-hydro

. Integrate heat recovery possibilities in the capital planning process

. Provide planning support to communities, Tribal Councils and local offices of DIAND

. Demonstration project(s) for heat recovery from existing or new diesel set.

130 . Integrate government decision on micro-hydro into the planning process - in other words, it should either be considered seriously for communities where appropriate or dropped altogether.

. Integrate wind-diesel demonstration results into the planning process

5-10 Years

170 . Integrate the output of research and development program regarding biomass into the planning process.

5.2 ACTION PLAN FOR STRATEGY ELEMENT B - COMMUNITY POWER - DEVELOPMENT AND DEMONSTRATION OF USE OF RENEWABLES

1-3 Years

210 . Monitor and assess the Ramsey gasifier project

. Assess the RCDP studies being conducted by/for Ontario Hydro (heat recovery, biomass) and Cat Lake (peat based electricity and space heating) and Biomass (four sites for biomass based electricity conversion)

. Monitor conversion technology

. Monitor the wood gathering aspects of the Strategy Element C

220 . If warranted based on research to this point, conduct 1-3 further biomass based demonstration projects

3-5 Years

230 . During the fourth year of strategy implementation it should be possible to begin to assess the potential for biomass based electricity generation. If the assessment is positive it should pave the way to widespread application of biomass options.

5.3 ACTION PLAN FOR STRATEGY ELEMENT C - SPACE HEATING - NATIVE SCHOOLS AND TEACHERAGES

1-3 Years

300 . Establish EMR-DIAND joint committee to develop approach.

310 . Establish criteria and identify dual fuel heating system demonstration sites and select 5 - 6 sites for retrofit

- Seek necessary capital budgets for heating systems

- Competition/selection of contractors as necessary

320 . Site specific technical evaluations/plan development

  - if options insulation/retrofit only then proceed to implementation

  - if dual fuel heating system included then proceed to discussion with Band re:
    - access to fuel wood
    - who to provide
    - contract and terms
    - price/volume

- Implementation supervised by DIAND district office using local labour where possible

330 . Evaluation

3-5 Years

340
- If successful, implement in remaining communities approximately 5 sites/year -- total program life is 5 years
- If unsuccessful, evaluate/identify reasons -- then no further action or revise/re-do demonstrations

5.4 ACTION PLAN FOR STRATEGY ELEMENT D - SPACE HEATING - NEW INSTITUTIONAL/COMMERCIAL FACILITIES

1-3 Years

410 . Select architects to undertake design work, possibly under RCDP

420 . Architects develop design criteria and standards in consultation with EMR, DPW, DIAND, H&W, MTC, and MOE.

- Develop standardized designs on modular basis for schools, teacherages, nursing stations

- Develop technology transfer/communications package

430 . Technology transfer involving seminars and presentations to key decision makers in DIAND, H&W, MTC, Hudson's Bay, etc.

3-5 Years

440 . Using standardized design for a demonstration project for 2-3 communities where a school or some appropriate building is planned

5.5 ACTION PLAN FOR STRATEGY ELEMENT E - NATIVE RESIDENCES AND BAND OFFICES

1-3 Years

500 . Establish working committee and liaison arrangements with Native leadership

510 . Select energy efficient housing firm - competitive bid. The Ontario Indian Housing Council may be an alternative vehicle.

520 . Develop design criteria in consultation with Native leadership

- Select demonstration communities - (3-5) in consultation with Native leadership

- Select retrofit houses/design of new energy efficient housing which would minimize (or eliminate) incremental cost over the present allowances (EMR - pay increment - if need established).

530 . Select Advisors

- Provide advisory service to Band(s) re materials purchase

- Program provides one or two persons for one month on-site in each community:

  - to adapt design to home site, train local carpenters and supervise new energy efficient construction

  - to train local carpenters and supervise retrofit
  - develop communications package to assist with technology transfer

- Houses would be built and retrofit program carried out
- Create awareness of demonstration and service among other communities through development of slide presentation and straightforward brochure
- Monitor results in terms of value of advisory service, satisfaction with new housing and retrofit measures, and savings in terms of fuel used.

540 . Assess the program and the housing designs and incorporate learning of first demonstration into program design for following year.

3-5 Years

550 -
570 . Repeat - 3 years until at least 3 or 4 energy efficient homes and renovated houses are completed in each Tribal Council area

580 . Thereafter a decision is required as to whether or not this service would be accepted into ongoing DIAND programming. DIAND currently provides resources for community planning, for hiring foremen for housing construction etc, and this effort could simply be built into that program structure or, alternatively, become a regular part of the funding for the Ontario Indian Housing Council.

5.6 ACTION PLAN FOR STRATEGY ELEMENT F - SPACE HEATING - RAIL COMMUNITIES

1-3 Years

600 . EMR to assess the results of MOE retrofit work in Armstrong study

610 . EMR to develop work with MOE in developing an initiative for the other communities in information and technology transfer.

620 . Planning study for all 13 communities.

630 . A technology transfer process should be established involving working out with each community an appropriate vehicle/timing for increasing awareness of potential benefits of energy efficiency and skills development. The recent findings from the Armstrong study funded under the RCDP and the housing demonstration program would be important sources for this program.

- While the special housing programs available for Natives are not available in rail communities, the advisory team could advise residents on how to use existing government programs to advantage.

- The technology transfer program could involve the training of individuals within the communities to carry out basic retrofitting. This could lead to part-time jobs for these people. Again the work here could build on the MOE sponsored retrofit program being carried out in Armstrong, extending some aspects of the program on a pilot basis to 2-3 communities.

640 . If sites are identified through the planning process for waste heat recovery, feasibility studies could be funded by the potential user of waste heat or Ontario Hydro, or possibly MOE.

3-5 Years

650 . Extend technology transfer to all communities, if the pilot program is assessed as effective and worthwhile.

5.7 ESTIMATED IMPLEMENTATION COSTS

For most of the proposed elements of the strategy it would be very difficult to provide more than a general indication of the total costs which could be involved in implementating the strategy. The following estimates and comments should be viewed as extremely preliminary:

Strategy Element	Total Costs
A. Heat Recovery from Community Power Installations	$100,000 to 150,000.
B. Community Power - Development and Demonstration of Use of Renewables	The incremental costs (over and above diesel installation) could range from several hundred thousand dollars to millions.
C. Space Heating Existing Schools and Teacherages, Native Communities	$10,000 per community.
D. Space Heating, New Industrial and Commercial Building Design	$100,000 to 250,000.
E. Residential Space Heating in Native Communities	$29,000 for design work, plus $8-10,000 per community for supervision.
F. Space Heating in Rail Communties	. Planning study for all communities, up to $100,000 . Technology transfer program $7-10,000 per community.

6.0 ORGANIZATIONAL IMPLICATIONS

Over the next five years it does not appear that significant organizational change would be required for the implementation of the strategy. If after further development and demonstration it appears that renewable energy (especially biomass) could form a widespread basis for community power systems, then it is possible that a new institutional framework for power delivery may make sense. For the moment, however, inter-agency arrangements among existing institutions offer the best prospects for the implementation of strategic elements including demonstration projects for electricity generation.

It is the view of the Study Team, however, that a great deal could be achieved in a number of areas if energy efficiency issues were addressed in the planning process for the remote communities. It is proposed therefore that a planning support capability in the form of staff resources and a modest budget for travel and studies be developed. It is further proposed that this capability be made available to the communities in support of their formal and informal planning processes. The communities were identified as the focal point for introducing the expertise because:

- they usually have the greatest direct interest in the outcome of the planning process;

- in Native communities at least, they have considerable control over the planning process; and,

- local residents will, in most cases, have a more comprehensive awareness of upcoming opportunities for intervention with respect to energy savings or the use of renewables.

There are two key areas of expertise required:

- expertise with regard to the potential for waste heat recovery planning process; and,

- expertise and training capacity in the construction of energy efficient new housing and in renovations.

With respect to Native communities, DIAND could consider developing the former by providing additional support to the Ontario Indian Housing Council to provide the latter. With respect to rail communities the approach outlined in Strategy Element F should provide residents and communities with the necessary knowledge to access existing sources of advice and assistance that are available to all residents of Ontario.

7.0 IMPLICATIONS OF THE STUDY FOR OTHER JURISDICTIONS

This study was limited to remote communities in Ontario. However, some of the findings and recommendations have wider applicability, particularly in the four western provinces. The Study Team was asked to identify thes implications in a general sense.

While there are differences between the provinces and territories within which there are remote communities, there are also many similarities. Many of the economic and technical factors associated with the use of renewable energy sources for the generation of electricity are similar in all jurisdictions including Newfoundland and the territories. The operation and facilities of the Federal Government and particularly of DIAND are much the same in the four western provinces, but quite different in Newfoundland and the North-West Territories. The Federal Government's relationship to non-Native remote communities in other jurisdictions is the same as for Ontario, except for the Territories.

The applicability of the recommended strategy to other jurisdictions varies then, by element of the strategy and by region. For example, the strategy element related to Native housing is considered applicable in the four western provinces because the DIAND and CMHC housing programs are essentially the same in these areas. It is unlikely to be applicable in Newfoundland since there are no remote Indian reserves in that province.

The following table summarizes the general applicability of strategy elements. It is emphasized that this view is based only on a general understanding of conditions and institutional arrangements in those jurisdictions.

Applicability of Strategy Elements in Other Jurisdictions

Strategy Element	**Applicability**	
	Four Western Provinces and Quebec	Newfoundland and Territories
A. Heat Recovery from Community Power Installations	.generally applicable for Native	.limited scope in Newfoundland .unsure about Territories
B. Community Power - Development and Demonstration of Use of Renewables	.generally applicable	.generally applicable
C. Space Heating Existing Schools and Teacherages, Native Communities	.generally applicable	
D. Space Heating, New Industrial and Commercial Building Design	.clearly applicable	.generally applicable
E. Residential Space Heating in Native Communities	.generally applicable	.probably not applicable
F. Space Heating in Rail Communities	.generally applicable	.applicable in Newfoundland .not in Territories

APPENDIX A: REMOTE COMMUNITIES

RAIL COMMUNITIES

1. Allanwater
2. Armstrong
3. Auden
4. Biscotasing
5. Collins
6. Ferland
7. Graham
8. Hillsport
9. Moose River Crossing
10. Oba
11. Ramsey
12. Sultan
13. Mud River

NATIVE COMMUNITIES

14. Attawapiskat
15. Fort Albany
16. Fort Severn
17. Kashechewan
18. Winisk
19. Angling Lake
20. Bearskin Lake
21. Big Trout Lake
22. Cat Lake
23. Deer Lake
24. Fort Hope
25. Gull Bay
26. Kasabonika
27. Kingfisher
28. Lac Seul
29. Lansdowne House
30. Muskrat Dam
31. North Spirit Lake
32. Ogoki/Marten Falls
33. Pikangikum
34. Poplar Hill
35. Sachigo Lake
36. Sandy Lake
37. Slate Falls
38. Summer Beaver
39. Weagamow
40. Webequie
41. Wunnummin Lake

APPENDIX B: REMOTE COMMUNITY PROFILES

Although it is always risky to define a "typical" remote Native community, a review of both the Remote Community Data Base and the Northern Community Energy Assessments studies, prepared for the Ontario Ministry of Energy indicates extensive similarity among communities, with respect to facilities, services and energy use patterns. For example:

- Residential Housing -- Much of the housing consists of 800 sq. ft., unserviced wood-frame houses which have sub-standard levels of insulation. Virtually all residential homes are heated by wood, often using very cheap, inefficient and often unsafe wood stoves. Newer housing tends to be of much better quality and the use of energy efficient wood stoves is increasing in new housing.

- Institutional Housing -- Where the provision of government services requires employees to live in the community, employees live in homes of generally higher quality than those of residents. These homes are heated by central forced-air oil furnaces and are fully serviced with private water-sewage facilities and, if community power is not available, electricity is provided by private diesel generation.

- School Facilities (DIAND) -- Almost every remote community has a primary school and teacherage. These facilities are typically serviced to southern standards -- central heating, water/sewage, electricity. Where no community power is available, private diesel sets are operated.

- Telephone Service (MTC/Bell) -- Virtually all communities have telephone service, however, in a few cases (smaller communities) services consist only of one or two pay telephones. Where a local exchange is in operation, it is powered by small diesel sets, if community power is unavailable.

- Health Facilities (Health and Welfare) -- In most communities, health facilities consist of small cabins, used intermittantly by visiting nurses and/or dentists. Larger, permanent facilities are located only in seven remote Native communities.* It is only in these latter locations, that significant energy is used for space heating and electricity needs.

- Transportation Facilities (MTC) -- All of the Native communities rely primarily on air access. Eighteen of the remote Native communities have MTC operated airport facilities; other communities must rely on ski and float planes. MTC facilities generally consist of one 3,500 foot runway, overnight accommodation, heavy equipment for runway maintenance and assorted storage/workshop facilities. Electricity, if not available from a community power system, is typically generated privately.

- Community Electricity Service -- Eligibility criteria for community electricity service were established by Ontario Hydro. These criteria are:

  - a minimum of 35 year-round customers willing to purchase power from Ontario Hydro; and,

  - assured year-round access to the community (road or 3,500 foot airstrips).

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* These seven Native communities are: Attawapiskat Fort Albany, Kaschewan, Big Trout Lake, Fort Hope, Pikangikum and Weaganow.

The Department of Indian Affairs and Northern Development (DIAND) generally contracts with Ontario Hydro for the installation, operation and maintenance of remote community power systems. The current status of electricity service in the remote Native communities is:

- 19 of the 28 Native communities included in this study are eligible for community electricity service;
- 11 of the eligible Native communities have full electricity service - 3 have partial service;
- 9 of the Native communities are not eligible under the present criteria for electricity service;
- plans are underway to extend electricity service to the remaining eligible Native communities, however, installation has not yet been completed; and,
- all community electricity service is provided by diesel generation.

Exhibit B-1 presents a profile of community electricity service in both Native and rail communities.

- Non-Native Commercial Facilities -- Hudson Bay Company operates stores and maintains a manager's residence in 14 of the remote Native communities. These facilities are typically centrally heated, and where no community power is available, electricity is generated by private diesel sets. Total fossil fuel consumption in these facilities is significant.

EXHIBIT 3-1

PROFILE OF

REMOTE COMMUNITY ELECTRICITY SERVICE

Community	House-holds	Popu-lation	Year-Round Access	Community Power	
A. RAIL					
1. Allanwater	11	50	Yes	No	
2. Armstrong	126	800	Yes	Yes	Ontario Hydro
3. Auden	20	85	Yes	No	
4. Biscotasing	30	52(P)	Yes	Yes	Ontario Hydro
5. Collins	22	100	Yes	Yes	Collins District Area School Board
6. Ferland	20	81	Yes	No	
7. Graham	12	30(P)	Yes	No	
8. Hillsport	19	68	Yes	Yes	Ontario Hydro
9. Moose River Crossing	44	90	Yes	No	
10. Oba	20	75	Yes	Yes	Ontario Hydro
11. Ramsey	21	127	Yes	Yes	E. B. Eddy
12. Sultan	67	179	Yes	Yes	Ontario Hydro
13. Mud River	10	40	Yes	No	
B. NATIVE					
14. Attawapiskat	157	828	Yes	Yes	Ontario Hydro
15. Fort Albany	130	447	Yes	Yes	Ontario Hydro
16. Fort Severn	49	318	Yes	No	
17. Kashechewan	130	798	Yes	Yes	(From Fort Albany)
18. Winisk	37	323	Yes	Partial	DIAND
19. Angling Lake	36	206	No	No	
20. Bearskin Lake	64	336	Yes	No	
21. Big Trout Lake	135	750	Yes	Parital	Ontario Hydro
22. Cat Lake	58	315	Yes	No	
23. Deer Lake	82	481	Yes	No	
24. Fort Hope	115	705	Yes	Yes	Fort Hope Power Authority
25. Gull Bay	55	286	Yes	Yes	Ontario Hydro
26. Kasabonika	83	444	Yes	No	
27. Kingfisher	50	253	No	No	
28. Lac Seul	105	537	No	No	
29. Lansdowne House	40	220	Yes	Yes	Ontario Hydro
30. Muskrat Dam	34	173	No	No	
31. North Spirit Lake	47	282	No	No	
32. Ogoki/Marten Falls	21	150	Yes	No	
33. Pikangikum	179	946	Yes	Yes	Ontario Hydro
34. Poplar Hill	36	171	No	No	
35. Sachigo Lake	53	339	Yes	No	
36. Sandy Lake	283	1,344	Yes	Yes	Ontario Hydro
37. Slate Falls	26	82	No	No	
38. Summer Beaver	60	250	No	Partial	Band
39. Weagamow	98	531	Yes	Yes	Ontario Hydro
40. Webequie	80	435	Yes	Yes	Ontario Hydro
41. Wunnummin Lake	65	318	No	No	

Source: Adapted from: Assessement of the Barriers to Alternative Remote Power Systems, Ministry of Energy, Toronto, 1982.

- Native Commercial Facilities -- Locally owned and operated Co-op stores, and/or dry goods stores are typically found in each community. Electricity is often either produced privately or purchased/shared with school diesel sets, if no community power exists.

The following summary provides a brief profile of the remote rail communities except for Armstrong and Ramsey.

- Housing -- With the exception of Armstrong and Ramsey, the majority of residential housing is similar to that found in the remote Native communities and is similarly heated by wood.

- School Facilities (Ministry of Education) -- Primary school facilities are located in eight of the communities. Service in these facilities is similar to DIAND facilities in Native communities.

- Telephone Service (MTC/Bell) -- Same as in Native communities

- Health Facilities (Ministry of Health) -- Only Armstrong has a permanent nursing station.

- Transportation Facilities -- Armstrong is the only rail community which has an MTC operated airstrip. All communities, of course, have rail access and eight of the communities are accessible by road.

- Community Electricity Service -- Rail communities must meet the same eligibility criteria previously outlined in order to receive community electricity service from Ontario Hydro. The current status of electricity service in the remote rail communities is:

    - 6 of the 13 rail communities are eligible for community electricity;

- all eligible communities have community electricity - Ontario Hydro is the operator in 5 locations and E. B. Eddy is the operator in Ramsey. One community - Collins - although not eligible under Hydro's criteria provides limited community electricity through the use of excess capacity in the school's diesel generation;
- 5 communities have no electricity service; and,
- With the exception of Sultan (micro-hydro) all community electricity service is provided by diesel generation.

APPENDIX C: ENERGY CONSUMPTION PATTERNS

The tabular information presented in Exhibits C-1 through C-7 provide breakdowns of fossil fuel and fuel oil consumption. Exhibit C-1 shows that the predominant fossil fuel is fuel oil. Exhibit C-2 presents a breakdown of the end-use applications of fuel oil. Gasoline is used exclusively for local transportation and the operation of other small motors (chainsaws, outboard motors, etc.).

Exhibits C-1 and C-2 demonstrate that even when wood consumption is excluded, there remains two principal targets for reducing energy use in Ontario remote communities - space heating and diesel electricity generation.

Exhibit C-3 shows fuel oil consumption by user in both Native and rail communities. As is shown, in each case, total fuel oil consumption (and consequently fossil fuel consumption) is in the hands of three identifiable target groups. In the Native communities, DINA, Ontario Hydro and MTC account for approximately 84% of consumption. In the rail communities, Ontario Hydro and the commercial and residential sectors (almost entirely located in Armstrong and Ramsey) account for approximately 87% of consumption.

Exhibits C-4 and C-5 show the consumption by end-user and end-use for Native and rail communities. Exhibit C-6 identifies the major users for Native and Rail Communities combined.

EXHIBIT C-1
FOSSIL FUEL CONSUMPTION
- BY FUEL TYPE
(16,240,000 litres)

Fuel	Native	Rail	Combined
Fuel Oil	81%	83%	82%
Gasoline	19%	17%	18%
	----	----	----
	100%	100%	100%

EXHIBIT C-2
FUEL OIL CONSUMPTION
- BY END USE
(13,240 litres)

End Use	Native	Rail	Consumption
Space Heating	40%	37%	38.5%
Electricity Generation	54%	46%	50%
Transportation	6%	17%	11.5%
	----	----	------
	100%	100%	100 %

EXHIBIT C-3

Fuel Oil Consumption By User
(13,240 litres)

1) Native

Ontario Hydro	36%
DIAND	35%
MTC/BELL Canada	12%
Health & Welfare	3%
Commercial	
Non-Native	9%
Native	4%
	100%

2) Rail

Ontario Hydro	23%
Ministry of Education	3%
CN Rail	8%
MTC	2%
Residential	20%
Commercial	44%
	100%

EXHIBIT C-4

Fuel Oil Consumption by User and End Use

NATIVE COMMUNITIES

	Space Heating			Electricity Generation			Transportation			Total	
	Litres	%	Total %	Litres	%	Total %	Litres	%	Total %	Litres	%
DINA	2,134,300	65.8	26.4	756,700	16.3	9.3	-	-	-	2,891,000	35.8
Ontario Hydro	-	-	-	2,989,000	64.5	37.0	-	-	-	2,989,000	37.0
MTC/Bell ONTC	242,100	7.4	3.0	465,100	10.0	5.8	195,900	100	2.4	903,100	11.2
Health & Welfare	281,500	8.6	3.5	-	-	-	-	-	-	281,500	3.5
Other Non-Native	449,300	13.9	5.6	202,100	4.4	2.5	-	-	-	651,400	8.1
Native	138,300	4.3	1.7	221,100	4.8	2.7	-	-	-	359,400	4.4
TOTAL	3,245,500	100	40.2	4,634,000	100	57.3	195,900	100	2.4	8,075,400	100

EXHIBIT C-5

Fuel Oil Consumption by User and End Use

RAIL COMMUNITIES

	Space Heating			Electricity Generation			Transportation			Total	
	Litres	%	Total %	Litres	%	Total %	Litres	%	Total %	Litres	%
Ontario Hydro	-	-	-	1,171,000	50.1	22.7	-	-	-	1,171,000	22.7
MTC/Bell ONTC	-	-	-	107,700	4.6	2.1	-	-	-	107,700	2.1
Commercial* and Other Institutions	940,000	47.8	18.2	1,059,800	45.0	20.5	860,000	100	17.2	2,859,800	55.3
Residents*	1,026,900	52.2	19.9	-	-	-	-	-	-	1,026,900	19.9
TOTAL	1,966,900	100	38.1	2,338,500	100	45.3	860,000	100	17.2	5,165,400	100

* Principally - Armstrong and Ramsey

EXHIBIT C-6
Fuel Oil Consumption
Native and Rail Communities Combined

	Space Heating			Electricity Generation			Transportation			Total	
	Litres	%	% Total	Litres	%	% Total	Litres	%	% Total	Litres	%
1. Ontario Hydro	-	-	-	4,160,000	59.7	31.4	-	-	-	4,160,000	31.4
2. DIAND	2,134,300	41.0	16.1	756,700	10.9	5.7	-	-	-	2,891,000	21.8
3. MTC/Bell/ONTC	242,100	4.6	1.8	572,800	8.2	4.3	195,900	18.6	1.5	1,010,800	7.6
4. Other Institutional/ Commercial	1,670,800	32.1	12.6	1,261,900	18.0	9.5	860,000	81.4	6.6	3,792,700	28.7
5. Residents	1,165,200	22.3	8.8	221,100	3.2	1.7	-	-	-	1,386,300	10.5
TOTAL	5,212,400	100.0	39.3	6,972,500	100.0	52.6	1,055,900	100.0	8.1	13,240,800	100.0

APPENDIX D

SUMMARY - REMOTE COMMUNITIES
RENEWABLE RESOURCE POTENTIAL

COMMUNITY	POPULATION	HOUSEHOLDS	FUEL OIL cents/1	WOOD	SMALL-SCALE HYDRAULIC	PEAT/ LIGNITE	WIND	SOLAR
NATIVE COASTAL								
Attawapiskat	828	157	43	3	0	2	2	2
Fort Albany	447	130	44	3	0	2	2	2
Fort Severn	318	49	94	2	0	2	3	2
Kashechewan	798	130	52	3	0	2	2	2
Winisk	232	37	85	2	0	2	2	2
NATIVE INTERIOR								
Angling Lake	206	36	64	4	1	2	1	2
Bearskin Lake	336	64	68	4	1	3	1	2
Big Trout Lake	750	135	68	4	1	2	1	2
Cat Lake	315	58	45	4	1	4	1	2
Deer Lake	481	82	54	4	3	1	1	2
Fort Hope	705	115	56	4	1	2	1	2
Gull Bay	286	55	30	4	0	2	1	2
Kasabonika	444	83	64	4	0	1	2	2
Kingfisher	253	50	64	4	0	2	2	2
Lac Seul	537	105	28	4	0	1	1	2
Lansdowne House	220	40	56	4	1	1	1	2
Muskrat Dam	173	34	54	4	3	4	2	2
North Spirit Lake	282	47	54	4	1	1	1	2
Ocoki	150	21	72	3	0	4	1	2
Pikangikum	946	179	51	4	4	1	1	2
Poplar Hill	171	36	55	4	3	2	1	2
Sachigo	339	53	55	4	0	3	2	2
Sandy Lake	1344	283	55	4	3	2	2	2
Slate Falls	82	26	57	4	0	3	1	2
Summer Beaver	250	60	99	4	0	2	1	2
Weagamow	531	98	41	4	0	2	1	2
Webequie	455	80	61	4	0	1	1	2
Wunnummin Lake	318	65	64	4	3	2	2	2
RAIL								
Alan Water	50	11	52	4	1	3	1	2
Armstrong	800	126	31	4	1	4	1	2
Auden	85	20	25	4	1	3	1	2
Biscotasing	52(P)	30	31	4	2	1	2	2
Collins	100	22	48	4	1	2	1	2
Ferland	81	20	24	4	0	4	1	2
Graham	30(P)	12	N/A	4	0	4	1	2
Hillsport	68	19	31	4	1	3	1	2
Moose River	90	44	N/A	4	0	3	1	2
Oba	75	20	25	4	3	4	1	2
Ramsey	127	21	28	4	2	3	1	2
Sultan	179	67	31	4	4*	3	1	2
Mud River	40	10	N/A	4	0	4	0	2

4= Excellent
3= Good
2= Adequate
1= Poor
0= None or Unknown
P= Permanent
*= site of small scale hydraulic demonstration

Source: Ontario Ministry of Energy, Remote Community Data Base, September 1982
Note: Representative light fuel oil price based on costs to largest volume consumer in the community for 1982.

APPENDIX E: TECHNICAL OPTIONS DESCRIPTION

Introduction

The technical options considered were developed in the context of the end-use and the responsibilities and activities of end-users. Thus the options relate not only to a specific technology but also to specific end-uses and end-users. A list of these is provided in the Exhibit at the end of this appendix.

Description of Options

1. Retrofit of Existing Residences

Improvement of insulation levels and air tightness in existing housing would greatly reduce the amount of wood used for space heating in remote communities. This in turn would increase the availability of sustainable wood resources near the community, allowing the use of locally harvested wood for institutional space heating (see option 6) or community power generation (see options 1,4 15, and 16). Important secondary benefits would be greatly improved comfort in existing housing and the possibility of local employment. There would be some reduction in the amount of gasoline used for snowmobiles in harvesting wood. Care would have to be taken that air infiltration rates remained high enough to supply adequate combustion air to the residence's wood stove. Retrofit plans for residential housing have been further developed under a separate study for the Windigo Band Council.

2. New Energy Efficient Residential Buildings

All new residential housing in remote communities could be built to energy efficient standards and be heated with an energy efficient wood stove. The benefits of this option are the same as for Option 1 -- freeing up wood resources for fuel-saving applications such as institutional or commercial space heating or community power generation. Standard low cost housing designs should be developed suitable for local construction with minimum site preparation.

3. Energy Efficient Wood Stoves

Replacement of existing wood stoves in residential housing with energy efficient wood space heating or cook stoves would, as in Options 1 and 2, free up local wood resources for local fuel-saving applications. Energy efficient wood stoves allow greater control of combustion air which would allow greater building air tightness (see Option 1). The ability to control combustion air, however, could result in slow burning of wet softwood, which in turn would cause dangerous creosote build-ups. Installation of energy efficient stoves would therefore, have to be accompanied with some local information on how to use them effectively.

4. Retrofit Existing Institutional and Commercial Buildings

Almost all institutional and commercial buildings in remote communities are heated with fuel oil and a great deal could be saved if the insulation levels and air tightness of the building were improved. Air tightness would be limited because of the continuing need for combustion air, although an exclusive combustion air inlet could be installed. This option would also provide some local employment. Expected energy savings from the use of this option would range from 30 - 40% and would include weatherstripping, improved windows/doors, and insulation levels.

5. New Energy Efficient Institutional and Commercial Buildings

All new commercial and institutional buildings as well as building extensions in remote communities should be built to energy efficient standards and be heated with wood/oil combination furnaces or boilers which also can provide hot water where necessary. If the building is to have its own electricity generator, waste heat from this unit should also be designed to contribute to the space heating load (see Option 7). New construction methods can reduce energy requirements for space heating in buildings to 10 - 20% of existing levels. In remote communities, the lack of labour with special skills, the difficulty of site preparation, and limited types of materials available would probably reduce the potential savings, though not significantly. Several energy efficient building designs for northern communities are currently being developed under separate projects. The designs have been further investigated as part of the study for the Windigo Tribal Council.

6. Wood/Oil Furnaces and Boilers

Replacement of existing fuel oil furnaces in institutional and commercial buildings with wood/oil combination furnaces or boilers would reduce the amount of fuel oil used in these buildings for space heating. Because retrofit of the buildings (Option 4) and use of waste heat recovered from electrical generators (Option 7), would greatly reduce the space heating demand, this option should be carried out in conjunction with the retrofit and heat recovery and the new unit sized for the reduced space heating demand. The advantage of a wood/oil boiler is that it can also be used to provide hot water in the building. The amount of oil savings would of course depend on the amount of wood available and the fraction of the time that the building's occupants could spend harvesting wood (unless purchased) and firing the heating unit. The use of infrequent loading units such as the Jetstream would probably result in higher oil savings.

7. Waste Heat Recovery from Institutional/Commercial Power Generation

Numerous institutional and commercial buildings in remote communities generate their own electricity. Waste heat from these generator sets may be used for space or water heating in adjacent buildings. The pay-back period on the equipment necessary to recover the waste heat (transfer pump, heat-exchangers, controls, etc.) is usually short (often as low as 1 year). It is therefore often cost-effective to install heat recovery systems even when future community power is scheduled. The amount of oil that would be displaced in a building by the use of waste heat from an electrical generator would depand on whether the unit was water or air cooled and on the distance between the generator and the facilities to be heated. If water cooled, up to 30% of the energy content of the fuel used for diesel electricity generation can be recovered for heating. If air cooled, up to 16% can be recovered. Heat recovery from a water cooled generator could therefore reduce space heating oil consumption by 25% (assuming a space heating furnace efficiency of 60%).

8. Waste Heat Recovery from Community Power Generators

Community power generation facilities are usually stand-alone facilities and are often located some distance from the community's institutional or commercial buildings. The amount of waste heat generated by these units is significant. The heat recovery potential from Native community power facilities would be equivalent to about 2.2 million litres of fuel oil used for space heating (30% recovery and 60% furnace efficiency) which is more fuel oil that was used to space heat all DIAND facilities in that year. Significant fuel oil savings could therefore be made if as many future community power systems as possible were located adjacent to the community's largest institutional or commercial building and waste heat was recovered from the unit to provide space and water heating. Exceptions would be in cases where community power was to be provided by small scale hydro, wood or peat combusion or gasification, or mechanically connected wind/diesel units, because of safety or other reasone. (See Options 12 to 17 inc.) Proper insulation of diesel power units would eliminate noise problems for the building occupants. In communities which already have community power, heat recovery for space or water heating in the nearest institutional or commercial building could be considered, or new community facilities such as laundromats and health centres located near the the facility.

Specific examples of waste heat recovery from existing and new community power facilities has been investigated under the study for the Windigo Tribal Council.

9. Cycle Charge Diesel Generators

Replacement of existing small diesel generators in MTC and Bell Canada communications facilities in remote communities with DC cycle-charge diesel units and batteries would result in significant reductions in fuel consumption in these facilities. This option will be investigated and demonstrated in more detail under separate studies for funded by the Ontario Ministry of Energy.

10. Small Wind/Diesel Hybrid Generators

Several MTC and Bell Canada communications facilities are located in areas where there is sufficient wind to operate a small (50 kw) wind generator and provide a significant fraction of the power needed to run the facility. The unit would need to produce DC power only. The most likely designs would be a vertical axis wind turbine or horizontal axis turbine with DC generator coupled electrically to the cycle charge diesel unit. This option will be investigated in more detail under a separate study for the MTC.

11. Solar Pholovoltaic/Diesel Hybrid Generators

The small power demand of communications equipment makes it possible to consider matched photovoltaic and diesel power generators at many MTC and Bell Canada communications facilities. As with the wind/diesel unit (Option 10) only DC power would need to be produced and matched with a cycle charge diesel system. This option will be investigated in more detail under a separate study for MTC.

12. Wind/Diesel Community Power Systems

An Ontario Hydro study has shown that in 4 coastal communities, wind/diesel community power could cost-effectively save significant quantities of oil. Trials of a 50 kw mechanically connected vertical axis wind turbine/diesel unit have been completed, and further trials on electrical and mechanical connection and asynchronous and synchronous generation are under way at a site near Sudbury. In the United States and United Kingdom and at the Prince Edward Island Atlantic Wind Test site, full scale operation of vertical axis and horizontal axis wind turbines suitable for remote community power (100 - 500 kw) are underway. These tests should show which type of wind turbine and diesel connection is most appropriate in the coastal communities and whether constant speed, self-starting, wind machines (e.g. horizontal axis with rotar tip control) might be suitable for use in remote communities with marginal wind speeds. Ontario Hydro is considering a demonstration wind/diesel community power system for Fort Severn.

14. Wood Gas/Diesel Fuel Community Power Systems

Wood gas generators of a size suitable for remote community power systems and matched dual fuel diesel internal combustion engines are not readily available. The smallest units are in the 500 - 700 kw range. Testing of larger dual fuel gasifier/diesel units have shown that some development work is still necessary, especially in the fuel injection area. Current systems also cannot run unattended and require an operator familiar with more complex stationary engines, the wood handling system, and the gasifier. The cost of a gasifier/generator system is high and with current fuel prices in remote communities cannot be economically justified even with free wood available. There is a potential, however, for the substitution of a local resource for fuel oil and future developments in gasifier technology may make this a viable option. For this reason new diesel only community power systems should consider installation of systems with dual fuel capability.

15. Wood Fired Steam Engine Community Power Systems

This technology is well developed and has been used for many years. The conversion efficiency of a reciprocating engine, however, is low and in most applications they have been replaced by steam turbines. A system rated at greater than 50 kw also requires a full time operator. The advantages of the system are its low cost (compared with gasification or turbine systems) and its reliability. While this option could almost completely displace fuel oil for community power (a back-up oil burner would be required), use of a steam engine may represent very poor use of the local wood resource because of the low conversion efficiency and would be unsuitable in communities where wood supply is marginal.

16. Wood Fired Steam, Gas, or Organic Turbine Community Power System

The most common method for generating electricity in conventional thermal power systems is to utilize the heat produced from combustion or nuclear fission to run a steam, gas, or organic Rankine cycle turbine. The efficiency is higher than in either an internal combustion or recipricating engine. The disadvantages are the high pressures, temperatures and costs involved, and the need for an experienced operator (although that too is required for any wood fired system - see Options 14 and 15). The advantage of an organic Rankine cycle system is that a steam boiler is not involved and therefore continuous monitoring is not manditory. A system of this type, however, has not been operated, unattended, in a remote environment.

17. Peat Fired Steam or Other Turbine Community Power Systems

Large scale peat fired steam turbine generator systems have been operated for many years in certain European countries. There is very little experience with small 100 - 500 kw systems. The difficulty of getting appropriate harvesting equipment into remote communities and the special skills required to maintain and operate peat harvesting and generating systems are further impediments to use of this option. Feasibility studies are underway for the MOE and other demonstrations and research work is being carried out in the Province of Newfoundland.

Summary

Exhibit E-1A is a summary assessment of the technical options presented. As is evident, the assessments provided are general in nature. Column 1, Potential Fuel Oil Savings, is a preliminary rating of the technical option's potential to reduce fuel oil consumption in a specific application. Column 2, Other Benefits, identifies direct benefits. Column 3, Initial Cost, provides a general indicator of only initial capital costs and does not represent calculation of life cycle costs, return on investment, etc. Finally, Column 4, Development Status, indicates the degree to which the technical option has been developed for application in remote locations.

Exhibit E-1A is useful, even at this preliminary stage of the project, in that it graphically depicts those options which:

- have the greatest potential for fuel oil savings;
- have the lowest initial cost; and,
- are technically most ready for application in remote location.

That is, technical Options 4 through 8 inclusive, directed towards reducing fuel oil consumption for space heating in institutional and commercial buildings consistently rate high within each of the columns.

From solely a technical perspective, these options therefore warrant serious focus. The Study Team recognized that the inclusion of additional assessment criteria - i.e. employment

EXHIBIT B-1A
SUMMARY ASSESSMENT OF TECHNICAL OPTIONS

	Potential Fuel Oil Savings (1)	Other Benefits (2)	Initial Cost (3)	Development Status (4)
A. Heating				
I Residential				
1. Retrofit of exisiting residences	Indirect*	Improved Housing Wood Conservation	Low	Good
2. New energy efficient residential buildings	Indirect*	Wood Conservation Improved Housing	Low	Excellent
3. Energy efficient wood stoves	Indirect*	Wood Conservation	Low	Excellent
II Institutional/Commercial				
4. Retrofit existing institutions and commercial buildings	V. High	Local Employment	Low	Excellent
5. New energy efficient institutions and commercial buildings	V. High	Local Employment	Low	Excellent
6. Wood/oil furnaces/boilers	V. High	Local Employment	Low	Excellent
7. Waste heat recovery from institutional/commercial power generators	V. High	Local Employment	Low	Excellent
8. Waste heat recovery from commercial power generators	V. High	Local Employment	Average	Excellent
B. Electricity				
I Communications				
9. Cycle-charge diesel for communications	High	Improved Reliability	Average	Adequate
10. Wind/diesel hybrid for comm.	Moderate	None	Average	Adequate
11. PV/diesel hybrid for comm.	Moderate	None	Average	Adequate
II Community Power				
12. Wind/diesel hybrid for com.pow.	Moderate	None	High	Adequate
13. Micro-Hydro for com.pow.	V. High	None	V. High	Good
14. Wood gas/diesel eng. com.pow.	High	Local Employment	V. High	Poor
15. Wood (fuel oil) steam eng.	High	Local Employment	V. High	Adequate
16. Wood (fuel oil) turbine	High	Local Employment	V. High	Poor
17. Peat (fuel oil) turbine	High	Local Employment	V. High	Poor

* Generation of wood in remote communities frees the resource for fuel-oil substitution

creation, institutional involvement in implementation, etc. - may alter this ranking. Nonetheless, the preliminary ranking suggested in Exhibit E-1A presents a valuable point of departure for input and discussion by Regional Advisory Committee members.